ECONOMIC BASE & NEEDS (PROJECTIONS)

BEAVER RIVER BASIN

APPENDIX IV

UTAH, NEVADA

MAY 1974

Prepared By
UNITED STATES
DEPARTMENT of AGRICULTURE
Economic Research Service - Forest Service
Soil Conservation Service
In cooperation with
UTAH STATE
DEPARTMENT of NATURAL RESOURCES

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The following publications have been prepared under the Beaver River Basin study:

Summary Report

Appendix I	Natural Resource Inventory Soils Supplement
Appendix II	Present and Projected Resource Use and Management Water Related Land Use Supplement Water Budget Analysis Supplement
Appendix III	Resource Related Problems
Appendix IV	Economic Base and Needs (Projections)
Appendix V	Potential Development Opportunities Irrigation Systems Supplement

APPENDIX IV

ECONOMIC BASE AND NEEDS (PROJECTIONS)

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ECONOMIC BASE AND NEEDS (PROJECTIONS)[1]

INTRODUCTION

PURPOSE

The purpose of this appendix is to provide economic information and analysis in planning potential development of land and water resources. Although primary emphasis is on the agricultural economy, information on other sectors of the economy is also included.

Historical trends and benchmark projections are presented. These projections set forth the direction the economy is expected to go without resource development under specified assumptions. Projections are provided for population, employment, income, water and related land use for target years 1980, 2000 and 2020 with implication of changes in assumptions. The projections are benchmark in nature and serve as a base for determining resource development needs and evaluating alternative development opportunities.

The impacts section gives emphasis to the use of the water resources, since it is recognized as the limiting resource. Land resources were studied as they related to water resource use and management.

STUDY AREA[2]

The Beaver River Basin includes 5,079,880 acres in Southwestern Utah and Southeastern Nevada. It is about 145 miles long and 116 miles wide at its longest and widest points (Map). The Basin is part of the Sevier Lake drainage, a major landlocked system within the Great Basin region. About 69,660 acres of the area are in Nevada with the remaining part in Utah.

The principal counties in the Basin are Iron, Beaver and Millard Counties in Utah. Minor areas within Sevier, Garfield and Washington Counties in Utah and Lincoln County, Nevada are also part of the area.

Less than 4 percent of the area is cropland and the remaining part is primarily mountainous and desert rangelands. There are four independent irrigated agricultural areas. These areas are shown on the map as subbasins.

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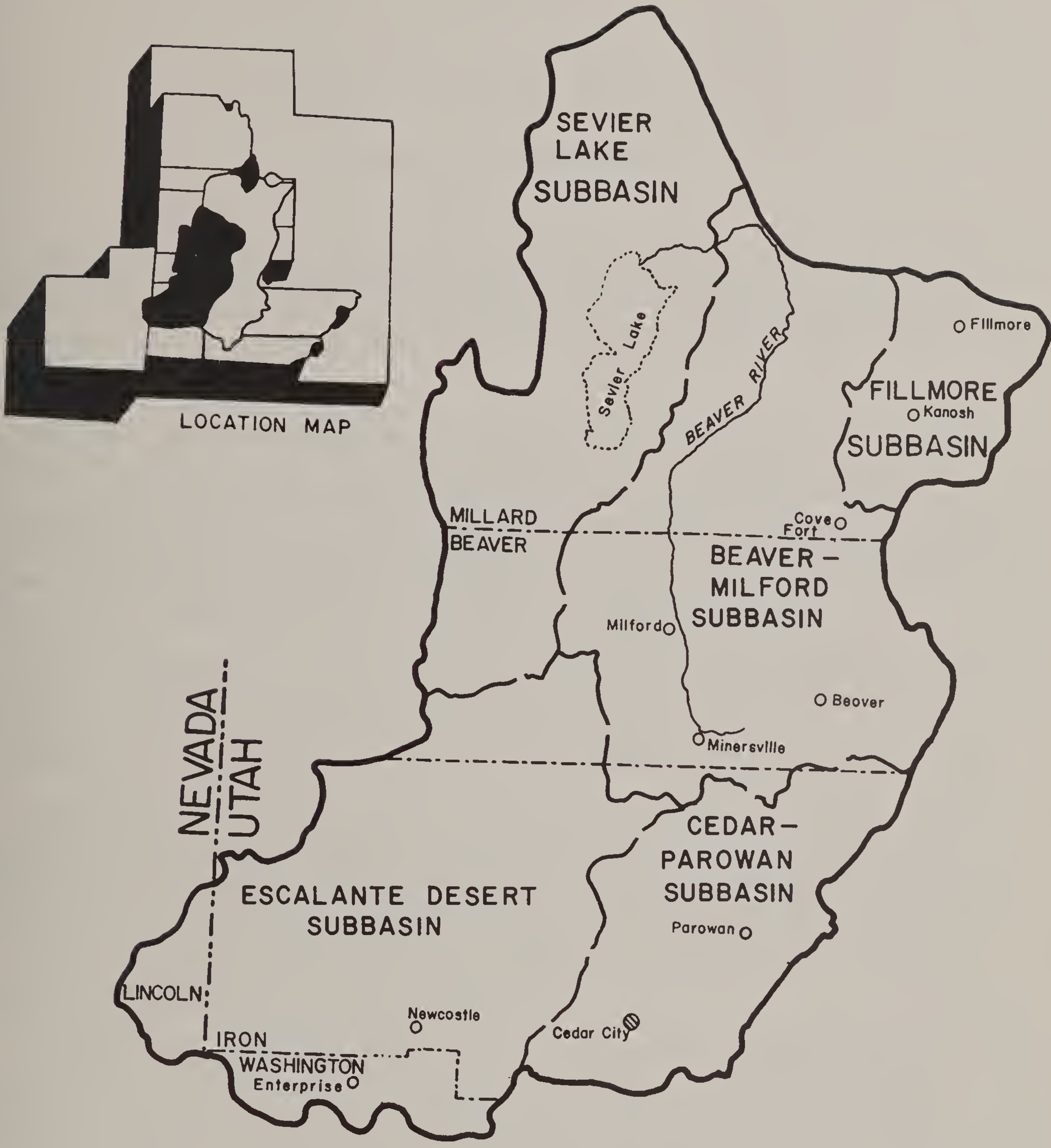
[1]Prepared by David L. Wilson, Economic Research Service representative on the U. S. Department of Agriculture River Basin Field Party, as a portion of the study of the water and related land resources of the Beaver River Basin.

[2]Does not include 162,370 acres of the Tintic Watershed in Juab County, Utah

Sharp contrasts in topography, climate, soils and precipitation are evident. Elevations range from 4,519 feet in the Sevier Desert to over 12,000 feet in the Tushar Mountains. Precipitation between these same areas varies from 6 to 40 inches annually. Frost-free periods in the agricultural areas vary from 107 days at Beaver to 156 days at Fillmore.

Surface waters seldom leave any of the subbasins. Surface waters are either diverted for irrigation or become part of the ground water reservoirs in the valley areas. Ground water pumping is a common practice in addition to surface water diversion for irrigation. The combined use of the available water resources results in an unusually high water use rate and declining ground water levels.

The Beaver River Basin provides sharp contrast in topography, soils, and vegetation. SCS PHOTO



COUNTIES AND SUBBASINS

BEAVER RIVER BASIN

UTAH–NEVADA

May 1974

10 5 0 10 20

SCALE IN MILES

LEGEND

SUBBASIN BOUNDARY

COUNTY BOUNDARY

Chapter I

HUMAN RESOURCES

HISTORICAL DEVELOPMENT

The first recorded white men to visit the Beaver River Basin were Fathers Escalante and Dominquez in 1776. They were looking for a route to California and investigating the existence of a "salt water lake." Fur trading and trapping followed, in 1826, when Jedediah Smith and others came to the area.

In 1849, Brigham Young sent an expedition from Salt Lake City to explore southern Utah to determine locations for settlement between the Salt Lake Valley and what is now Arizona. The announced goal was to "establish a chain of forts from Salt Lake City to the Pacific Ocean." Over a three-month period, the expedition covered 800 miles, making detailed records on topography, available grazing, water, vegetation, timber supplies and favorable locations for settlements.[1]

The expedition's report was quickly put to use. In the same year, a group was sent to settle Little Salt Lake Valley (Parowan). The following year settlements were made in the Pahvant Valley (Fillmore) and another in the Little Salt Lake Valley (Cedar Fort or Cedar City).

The early settlement of Parowan was important because this site provided a half-way station to California and an agricultural base to support an "iron mission" at Cedar City. Parowan also served as a nucleus for establishing a number of settlements in the region during the 1850's. Parowan was settled by a group of 35 families containing 167 people who left Salt Lake City in December, 1849. In 1851 crops were harvested from 1000 acres of land.[2]

In November, 1851, a company of settlers from Parowan occupied Cedar Fort, 17 miles to the southwest of Parowan. An iron furnace was built in 1852, but was idle most of the year for lack of hands. In October, 1852, additional iron-workers and farmers arrived from Salt Lake City.

On Chalk Creek in Pahvant Valley, Brigham Young selected a site for the first capital of Utah and named it Fillmore in honor of the President of the United States. During 1852, the foundation for the state house was laid and homes were erected. By the close of the year, 70 families were living in Fillmore.

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[1]Leonard J. Arrington, Great Basin Kingdom, University of Nebraska Press, 1966, p. 86.

[2]Ibid.

In 1856, twenty men and their families left Parowan to settle Beaver. These settlers, mostly cattlemen, were interested in the Beaver Valley grazing lands. Water was diverted from the Beaver River and irrigated crops established. Three years later, Minersville, 17 miles west of Beaver, was established for the purpose of mining local lead, zinc and silver deposits.

A railroad was completed in 1880, which connected Milford and Salt Lake City, to facilitate the transportation of silver ore, discovered in the San Francisco Mountains in the 1860's, to Salt Lake City for smeltering. The railroad also established Milford as a transportation center for agricultural products produced in the Basin. Later on the railroad was extended to Cedar City and California.

The colonization and development followed the traditional Mormon (military fashion) pattern. Settlement and development was a directed movement, which included entire new communities according to carefully worked out plans, rather than spontaneous and individual movements. Settlement companies were organized in groups of 10, 50 and 100 with appointed leaders. Upon reaching their destination, the colonists retained their organization. Development of the community was always done on a cooperative basis. The first order of business was to build a fort. Next, organized groups started "public works" projects of digging irrigation canals, erecting fences, planting crops, and building roads and homes.

The distribution and use of the land and water resources was also done on a controlled and systematic basis. The distribution of lands at Parowan is a good example. Acre lots within the community were surveyed and assigned numbers and then distributed in a community drawing with each family receiving one lot. On these lots families built their homes, planted gardens, and erected livestock sheds.

Outside of the town, the irrigable lands were surveyed into 10 acre-tracts of first- and second-class lands. The same procedure was used in distributing these lands. Three drawings were held in all, with each family getting a city lot, 10 acres of first-class land and 10 acres of second-class land. Lands outside of city lots and irrigated tracts were treated as common property. Cattle were collected into herds and grazed together.[1]

Early settlers in Utah soon recognized that irrigation was necessary for successful agricultural production. They soon adopted the

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[1] Ibid., pp. 89-95

principle that land and water resources were subject to public rather than private ownership. The Mormon policy was as follows:

> "There shall be no private ownership of the streams that come out of the canyons, nor the timber that grows on the hills. These belong to the people: all the people."[1]

The decision with respect to water was probably the most important. They had no precedent to guide them, because Anglo-Saxon law used in the East provided that water must not be taken from the streams unless returned in the same volume. It was obvious that the use of water for irrigation robbed a stream of part of its water supply. The Mormons worked out an arrangement where dams and ditches were built on a community basis, rights to use the water were associated with the utilization of the land, and a public authority was appointed to supervise the appropriation and distribution of water. Their goal was the equitable division and maximum use of the available water supplies.[2]

Generally, the appropriation and distribution of irrigation water followed a "public works" type pattern. When a group of families found themselves in need of water, a construction company was organized. Each man was required to furnish labor in proportion to the amount of his irrigable land. Water was then distributed in proportion to the work done. Maintenance and repair work was done in the same manner.

When Utah became a territory this system of public ownership was confirmed. The territorial government also provided for the creation of irrigation districts in 1865. According to Thomas, the vast majority of irrigation works in Utah, "were built by the farmers, owned by the farmers, and operated by the farmers. In fact they constitute one of the greatest and most successful community or cooperative undertakings in the history of America."[3]

The same principles were used in the allocation and use of the timber resource. Timber was located in the canyons adjacent to settlements and could not be procured without access roads. Access roads were constructed on a community basis and later were maintained on a user fee basis.

Settlement and development was not all agriculturally oriented. Cedar City was the site of a pioneer iron industry. The first iron

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[1] Ibid., p. 52.

[2] Ibid., pp. 52-53.

[3] Thomas, <u>Development of Institutions Under Irrigation</u>, p. 27.

was produced here in 1852. Iron production was plagued by problems. In July, 1853, work was suspended due to Indian uprisings and in September the site was destroyed by a flood. In 1856 work was hampered by a drought, grasshopper plague and floods. Iron operations were intermittent over the next 75 years. In 1924, iron operations were developed on a large scale and by 1962, 67 million long-tons of ore have been produced.[1]

Natural disasters and hazards have been numerous over the years. Drought, insect infestation, flood and severe winters have plagued the area. In 1855 and 1856 a drought and grasshopper infestation reduced agricultural production to the point that the people were in a position of near semi-starvation.

The prime economic problem of Mormon Country in the 1870's and 1880's were overpopulation in relation to the developed resource. Immigration flows and the natural increase in population were showing signs of filling up the land. History indicates that all the land and water were appropriated. Young married couples were unable to find farms near home and older people were under-employed. At this point, the Church started projects to increase the supply of irrigated lands and supported the movement of people to adjacent states, Canada and Mexico. The overpopulation in relation to the resource base has continued and is evident in the economy today.

TRENDS

POPULATION

In general terms, economic conditions vary from an active growth area around Cedar City to declining populations in the Beaver, Milford and Fillmore areas (Table 1). Economic activity in the Beaver and Fillmore areas is primarily related to agriculture. Mining, agriculture and railroad activities are all important elements of economic activities in the Milford area. Expansion in mining and service sectors has provided employment opportunities for economic growth in the Cedar City area.

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[1] U. S. Geological Survey, Mineral and Water Resources of Utah, 1964.

Table 1.--Population of selected incorporated and unincorporated places, Beaver River Basin, selected years, 1940-1970

Place	County	Year 1940	1950	1960	1970
		Number			
Beaver	Beaver	1,808	1,685	1,548	1,453
Cedar City	Iron	4,695	6,106	7,543	8,946
Enterprise	Washington	619	790	859	844
Enoch	Iron	-----	-----	250	120
Fillmore	Millard	1,785	1,890	1,602	1,411
Kanosh	Millard	526	476	499	319
Minersville	Beaver	570	593	580	448
Meadow	Millard	422	378	244	238
Milford	Beaver	1,396	1,673	1,471	1,304
Paragonah	Iron	365	404	300	275
Parowan	Iron	1,525	1,455	1,486	1,423

Source: U. S. Census of Population

Cedar City is the only community in the area that has experienced consistent population increases over the last 30 years. Fillmore, Milford, Minersville, and Paragonah all had population increases from 1940 to 1950, but have declined since 1950. Beaver, Parowan, Meadow, and Kanosh have all had declining populations over the last 30 years.

Table 2.--Population of Basin Counties, selected years, 1890-1970

Year	County: Beaver	Iron	Millard
	Number		
1890	3,340	2,683	4,033
1900	3,613	3,546	5,678
1910	4,717	3,933	6,118
1920	5,139	5,787	9,659
1930	5,136	7,227	9,945
1940	5,014	8,331	9,613
1950	4,856	9,642	9,387
1960	4,331	10,705	7,866
1970	3,800	12,177	6,988

Source: U. S. Census of Population

The population within the study area was stable between 1960 and 1970 (Table 3). A small decrease was recorded between 1950 and 1960, however, the population had been increasing prior to 1950. From 1900 to 1950 the population increased by 95 percent. The portion that the Basin population is of the State population has been decreasing since 1920. In 1920, the Basin population was 3.37 percent of the State and in 1970 it had decreased to 1.74 percent. From 1950 to 1970 the Basin population decreased by 2 percent while the State population increased by 54 percent.

Table 3.--Population of Beaver River Basin and State of Utah, selected years, 1890-1970

Year	Beaver River Basin[a]	Utah	Basin as portion of State
	--------Number	----------------	----Percent-----
1890	7,876	207,095	3.80
1900	9,682	276,749	3.50
1910	11,381	373,351	3.05
1920	15,127	449,396	3.37
1930	16,726	507,847	3.29
1940	17,738	550,310	3.22
1950	18,853	668,862	2.74
1960	18,427	890,627	2.07
1970	18,448	1,059,273	1.74

[a]Does not include the Tintic Watershed area. County population figures were adjusted to reflect Beaver River Basin boundaries.

Source: U. S. Census of Population

Table 4.--Population by subbasin, Beaver River Basin, selected years, 1940-1970

Year	Subbasin				Beaver River Basin[b]
	Fillmore[a]	Beaver-Milford	Cedar-Parowan	Escalante Desert	
	---------------------------		Number	----------------------------	
1940	3,618	5,014	8,056	1,050	17,738
1950	3,533	4,856	9,124	1,340	18,853
1960	2,628	4,331	10,010	1,458	18,427
1970	2,193	3,800	10,966	1,489	18,448

[a]Does not include the Tintic Watershed area.
[b]County population figures were adjusted to reflect Beaver River Basin boundaries using census districts.

Source: U. S. Census of Population

There are noticeable differences between populations and their identifying characteristics, both within the counties, Basin and the State population. There is a higher portion of the population in Beaver and Millard Counties represented in the 45 years of age and over groups and a smaller portion of the population under 45 years of age when compared to Iron County and the State populations. This is partly due to the presence of a college at Cedar City (Table 5). Median age levels are as follows: Beaver County, 29.1 years; Millard County, 27.8 years; Iron County, 22.5 years and the State, 25.2 years (Table 6).

Table 5.--Percentage distribution of populations by age group for Basin counties, State of Utah and United States, 1970

Age Group	Beaver County	Iron County	Millard County	Beaver River Basin Counties	State of Utah	United States
	Percentage					
Under 5	8.41	10.45	9.26	9.90	10.55	8.45
5-14	21.57	20.05	22.97	20.73	22.72	20.06
15-24	15.68	25.41	14.95	22.25	20.25	17.44
25-34	9.24	10.46	8.86	10.04	12.27	12.26
35-44	10.00	9.63	9.85	9.73	10.16	11.35
45-54	12.53	9.21	10.71	10.04	9.53	11.42
55-64	11.00	7.17	10.86	8.34	7.20	9.15
65-74	7.52	4.92	8.01	5.79	4.55	6.11
Over 75	4.05	1.70	4.53	3.18	2.77	3.76

Source: U. S. Census of Population

All the Basin counties show deficits in the 25-34 age group, and Beaver and Millard Counties also have sizeable deficits in the 15-24 age group when compared with the State. These deficits would indicate that the young people are leaving the Basin after finishing their education. The portion of the population in the older dependent age groups (65+ age groups) in Beaver and Millard Counties is nearly double the percentage in Iron County and the State.

Other identifying characteristics are shown in Table 6. Some significant traits are: (1) the percentage of the population engaged in agriculture in Iron County is double, and Beaver and Millard Counties are several times larger than for the State; (2) the counties with a high portion of their population engaged in agriculture also

have a high portion of the families below the poverty level and lower education attainment levels and (3) the mean family income and the per capita income level is considerably below comparable State figures.

Table 6.--Various attributes of the population, Basin Counties and State of Utah, 1970

Attribute	Unit	County: Beaver	County: Iron	County: Millard	Basin Counties	State of Utah
Population	Number	3,800	12,177	6,988	22,965	1,059,273
Male	Number	1,919	6,184	3,478	11,581	523,265
Female	Number	1,881	5,993	3,510	11,384	536,008
Under 18 years	Number	1,431	4,547	2,861	8,839	423,850
65 years and over	Number	440	929	877	2,246	77,561
Median age	Year	29.1	22.5	27.8	25.2	23.1
Dependency ratio[a]	Number	.97	.82	1.15	.93	.90
Families	Number	1,007	2,858	1,756	5,621	249,741
Persons per household	Number	3.18	3.42	3.33	3.35	3.46
Mean family income	Dollar	8,014	8,624	7,389	7,548	10,428
Poverty level families	Number	202	288	293	783	22,802
Mean family income	Dollar	1,648	1,942	1,953	1,870	1,970
Portion of total families	Percent	20.0	10.1	16.7	13.9	9.1
Labor force[b]	Number	1,451	4,827	2,684	8,962	403,634
Employment	Number	1,413	4,581	2,525	8,519	378,562
Private wage and salary	Number	862	2,686	1,344	4,892	253,202
Government	Number	222	1,403	535	2,160	95,553
Self-employed	Number	319	476	626	1,421	28,122
Unpaid family	Number	10	16	20	46	1,433
Unemployed	Number	38	213	159	410	20,600
Employed in agriculture	Number	246	331	554	1,131	13,335
Portion unemployed	Percent	2.6	4.4	5.9	4.6	5.2
Portion unemployed in agriculture	Percent	17.0	6.9	20.6	12.6	3.3
Median education level[c]	Year	12.3	12.8	12.4	12.6	12.5
Portion finishing high school[c]	Percent	60.7	73.9	62.8	68.3	67.3
Per capita income	Dollar	2,328	2,275	2,026	2,208	2,703

[a] A dependency ratio of 1:1 means that there is one independent (18-64 years) for each dependent (below 18 or above 64) person.

[b] Persons 16 years of age and over.

[c] Persons 25 years of age and over.

Source: U. S. Census of Population.

EMPLOYMENT

Employment has increased slightly during the last 15 years. The work force in Beaver and Millard Counties has been relatively stable with increased employment in the Basin in Iron County. Some changes are developing between job categories. Manufacturing, trade, finance, service and government sector have been increasing. The transportation, mining and agricultural sectors have been decreasing, while the construction sector has been variable from year to year (Table 7).

The number of people employed in the agriculture and mining sectors decreased by about 50 percent between 1956 and 1970. During the same period, employment in other sectors increased as follows: manufacturing, 540 percent; trade, 35 percent; finance, 157 percent; service, 28 percent and government, 76 percent. Employment in the transportation sector decreased by 40 percent. These trends are generally expected to continue.

Unemployment has usually been slightly higher than for the State. However, more recently, the rate has been lower than for the State.

A detailed breakdown of the number of jobs for census years 1960 and 1970 are shown in Tables 8 and 9. The total number of people employed in Beaver and Millard Counties remained about the same despite large population decreases. This would indicate that a larger portion of the population is joining the work force.

Changes in employment patterns were not the same in all counties. Beaver and Millard increased employment in mining; at the same time, Iron County had a large decrease. All the counties decreased in agricultural employment, but the decrease in Millard County was larger. Large increases in employment have occurred in all counties for manufacturing, health services and educational services.

Employment in the agricultural sector has been decreasing.

Table 7.--Average annual work force, employment, unemployment and type of employment, Beaver River Basin, 1956-1970[a]

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
	Number														
Work force	6,907	6,834	6,915	6,915	6,870	6,856	6,844	6,760	7,197	7,078	7,330	7,479	7,464	7,483	7,441
Unemployment	380	372	416	420	395	444	348	355	506	344	373	364	357	350	401
Rate (percent)	5.5	5.4	6.0	6.1	5.7	6.5	5.1	5.3	7.0	4.9	5.1	4.9	4.8	4.7	5.4
Employment	6,527	6,462	6,499	6,495	6,475	6,412	6,496	6,405	6,691	6,734	6,947	7,115	7,107	7,133	7,040
Manufacturing	73	78	105	122	136	132	134	167	197	246	315	406	419	491	467
Mining	637	711	651	579	631	619	499	393	361	399	342	318	324	329	377
Construction	135	118	153	203	186	189	224	213	192	206	202	231	252	353	204
Transportation	772	747	679	657	617	592	582	569	577	507	483	496	532	457	461
Trade	954	969	983	998	982	1,027	1,048	1,070	1,118	1,137	1,187	1,182	1,221	1,250	1,289
Finance	58	60	66	67	77	80	85	91	105	115	124	128	131	136	149
Service	529	513	480	492	464	452	468	496	505	534	553	588	622	635	678
Government	1,043	968	1,079	1,126	1,168	1,197	1,321	1,380	1,477	1,610	1,858	1,951	1,885	1,820	1,833
Agriculture	1,465	1,403	1,385	1,321	1,292	1,222	1,255	1,145	1,161	1,006	939	873	880	811	741
All other	861	895	919	930	922	902	880	881	998	974	944	942	841	851	841

[a]Individual county data adjusted to reflect Beaver River Basin boundaries.

Source: Unpublished county employment data provided by Utah State Department of Employment Security

Table 8.--Number of persons employed by major industries, Basin Counties, 1960

Industry Group	County: Beaver	Iron	Millard	Basin Counties
	Number			
Agriculture, forestry & fisheries	312	504	924	1,740
Mining	29	473	24	526
Construction	109	283	120	512
Manufacturing	30	155	77	262
Railroad & railway express service	296	110	83	489
Trucking service & warehousing	13	53	36	102
Other transportation	3	11	20	34
Communications	4	60	55	119
Utilities & sanitary service	34	67	47	148
Wholesale trade	9	165	44	218
Food & dairy product stores	19	101	39	159
Eating & drinking places	109	136	77	322
Other retail trade	151	449	339	939
Finance, insurance & real estate	14	72	42	128
Business & repair services	15	85	52	152
Private households	6	32	48	86
Other personal services	47	176	85	308
Entertainment & recreational services	15	17	5	37
Hospital & health services	15	82	32	129
Educational services	90	329	183	602
Welfare, religious & nonprofit	7	32	15	54
Other professional & related services	29	129	23	181
Public administration	53	144	125	322
Industry not reported	17	111	42	170
Total	1,426	3,776	2,537	7,739

Source: U. S. Census of Population

Table 9.--Number of persons employed by major industries, Basin Counties, 1970

Industry Group	County: Beaver	County: Iron	County: Millard	Basin Counties
	---------------Number-----------			
Agriculture, forestry & fisheries	251	385	559	1,195
Mining	46	219	128	393
Construction	119	343	147	609
Manufacturing	77	299	174	550
Railroad & railway express services	179	54	40	273
Trucking service & warehousing	6	56	28	90
Other transportation	---	43	23	66
Communications	---	76	71	147
Utilities & sanitary service	41	69	27	137
Wholesale trade	20	104	22	146
Food & dairy product stores	32	124	106	262
Eating & drinking places	112	227	103	442
Other retail trade	150	637	274	1,061
Finance, insurance & real estate	4	128	78	210
Business & repair services	8	106	55	169
Private households	16	24	37	77
Other personal services	91	259	84	434
Entertainment & recreational services	10	48	4	62
Hospital & health services	68	190	84	342
Educational services	105	796	311	1,212
Welfare, religious & nonprofit	---	31	9	40
Other professional & related services	12	75	17	104
Public administration	66	288	144	498
Total	1,413	4,581	2,525	8,519

Source: U. S. Census of Population

Table 10.--Employment by sector, Beaver River Basin, selected years 1940-1970

	Agriculture and Forestry	Mining	Manu-facturing	Other	Total
	Number				
1940	1,850	640	50	1,910	4,450
1950	2,000	690	100	3,360	6,150
1960	1,300	625	140	4,435	6,500
1970	1,000	500	475	5,130	7,000

Source: 1968 OBE-ERS water resource planning projections adjusted to fit Beaver River Basin area.

PERSONAL INCOME

Personal income has been increasing. Total personal income increased from $25.9 million in 1958 to $46.4 million in 1968 (Table 11). The trend has been for gradual increases in income from wage and salary disbursements, property income and transfer payments. Proprietors' income has varied from year to year. These variations have resulted in total personal income varying.

In 1960, wates and salaries accounted for 61 percent of the personal income in the area; proprietors' income, 19 percent; property income, 11 percent and transfer payments, 8 percent. By 1968, wages and salaries accounted for 57 percent; proprietors' income, 17 percent; property income, 17 percent and transfer payments, 9 percent.

During 1960, 2.07 percent of the State's population resided in the Basin and their personal income was only 1.83 percent of the State total. This resulted in a 1960 per capita income deficit of $245. By 1968, the per capita income deficit had increased to $282.

Personal income, in terms of 1965 dollars, is shown in Table 12. Personal income in terms of constant dollars has increased from $28.1 million in 1950 to $40.9 million in 1970.

Table 11.--Personal income by source of income, Beaver River Basin, 1958-1968[a]

Table 11.--Personal income by source of income, Beaver River Basin, 1958-1968[a]

Item	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
	1,000 Dollars										
Personal income	25,856	30,011	30,675	31,658	33,916	34,571	34,968	37,812	39,711	42,998	46,392
Wage and salary disbursements	17,111	18,060	18,750	19,324	19,732	19,930	20,750	21,727	22,759	23,989	26,488
Other labor income	570	584	687	723	780	830	887	960	988	1,037	1,153
Proprietors' income	3,720	6,377	5,882	5,597	7,004	6,250	5,621	6,800	7,122	8,271	7,987
Farm	753	3,165	2,793	2,323	3,484	3,936	3,160	4,298	4,495	5,580	5,176
Nonfarm	2,967	3,212	3,089	3,274	3,520	2,314	2,461	2,502	2,627	2,691	2,811
Property Income	2,853	3,196	3,507	3,974	4,302	5,787	5,828	6,256	6,664	7,173	7,825
Transfer Payments	2,255	2,408	2,540	2,761	2,894	2,544	2,706	2,938	3,260	3,780	4,336
Less: contributions for social insurance	653	614	691	721	796	770	824	869	1,082	1,252	1,397

[a] Individual county data adjusted to reflect Beaver River Basin boundaries.

Source: Hanks, J. Whitney, Personal Income in Utah Counties, 1958-1969, Center for Economic and Community Development, Bureau of Economic and Business Research, University of Utah, March, 1970.

Table 12.--Personal income and per capita income, Beaver River Basin, selected years, 1940-1970[a]

Year	Personal income	Per capita income	Earnings per worker
	1,000 dollars	Dollar	Dollar
1940	15,805	891	3,350
1950	28,110	1,491	4,100
1959	30,863	1,675	4,354
1970	40,862	2,215	5,072

[a]In terms of 1965 dollars.

Source: 1968 OBE-ERS water resource planning projections.

Personal income has been increasing.
SCS PHOTO

CHAPTER II

A G R I C U L T U R A L   E C O N O M Y

TRENDS

PROCEDURES

Data from the U. S. Census of Agriculture were used to establish trends within agriculture over the 1949-1964 period. County census data were adjusted to represent conditions within the Beaver River Basin. In cases where only a portion of the county was in the Basin, county census figures were adjusted on a percentage basis to reflect the Basin area. It was assumed that county figures were representative of the Basin area in the counties. County data and adjusted county data were consolidated to represent the Basin area.

FARMS

The trend has been for the number of farms to decrease. The number of farms decreased from 1,257 in 1949 to 890 in 1964 (Table 13). This is a decrease of 30 percent in the 15 year period.

Table 13.--Characteristics of farms within the Beaver River Basin, census years, 1949-1964

Year	Farms	Land in farms	Average size of farm
	Number	Acre	Acre
1949	1,257	862,224	685.9
1954	1,207	1,028,650	852.2
1959	1,037	1,155,523	1,114.3
1964	890	1,053,223	1,184.0

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

The average size of farms has increased from 686 acres in 1949 to 1,184 acres in 1964. The farm consolidation process is expected to continue in the future. The land in farms increased considerably during the 1949-1954 period but has been relatively stable since 1954.

IRRIGATED FARMS

The number of irrigated farms has also been decreasing. In 1949 there were 1,021 farms; 1954, 939 farms; 1959, 806 farms and in 1964 704 farms (Table 14). The number of farms with no irrigated land on them are as follows: 1949, 236 farms; 1954, 268 farms; 1959, 231 farms and in 1964, 186 farms.

Table 14.--Number of irrigated farms and acreage within the Beaver River Basin, census years, 1949-1964

Census Year	Irrigated farms	Land in irrigated farms	Land irrigated	Irrigated cropland harvested	Irrigated pasture
	Number	---------	1,000 Acres	---------	---------
1949	1,021	654.3	77.8	66.0	11.8
1954	939	750.8	78.7	66.0	12.7
1959	806	741.0	75.5	58.8	16.7
1964	704	784.9	80.1	63.6	16.5

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

Land in irrigated farms has been increasing. In 1949, there were 654,300 acres of land in irrigated farms and by 1964 this acreage had increased to 784,900 acres. The average size of irrigated farms for census years is as follows: 1949, 641 acres; 1954, 800 acres; 1959, 919 acres and in 1964, 1,115 acres. Average irrigated acreage on these farms was 76 in 1949; 84 in 1954; 94 in 1959 and 114 in 1964.

CROP PRODUCTION

Total cropland harvested has varied over the years because of irrigation water supply conditions and the influence of government farm programs. The acreage of cropland harvested by dry and irrigated categories is shown in Table 15. Dry cropland harvested has been decreasing due to the influence of farm programs and the marginal character of dryland farming. Irrigated cropland harvested has varied between census years because of fluctuating irrigation water supplies and substitution of irrigated pasture for irrigated cropland.

Table 15.--Cropland harvested, Beaver River Basin, census years 1949-1964

Item	1949	1954	1959	1964
	Acres			
Dry cropland harvested	27,690	25,200	15,200	14,100
Irrigated cropland harvested	65,970	66,000	58,800	63,700
Total cropland harvested	93,660	91,200	74,000	77,800

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

Acreage, yields per acre and total production of various crops grown are shown in Tables 16-18. Data in these tables indicate a trend toward increased forage production. The production of grain crops has been decreasing during the 1949-1964 period. The acreage and yield of potatoes and sugar beets have varied from year to year. The yield per acre of alfalfa hay, barley and spring wheat have all been increasing during the 1949-1964 period.

Table 16.--Harvest acreage by crops, Beaver River Basin, census years 1949-1964

Crop	1949	1954	1959	1964
Alfalfa hay[a]	35,335	43,012	37,434	40,782
Other tame hay[a]	------	------	2,323	3,027
Native hay[a]	------	------	258	315
Alfalfa seed[b]	8,502	8,958	6,495	8,749
Barley	11,443	9,561	9,237	7,458
Wheat (winter)	27,255	21,700	8,932	6,992
Wheat (spring)	2,328	2,347	1,532	655
Oats	2,133	1,701	656	984
Potatoes	2,565	2,743	2,201	3,195
Sugar beets	202	446	83	783
Corn silage	2,483	2,318	2,803	2,384
Pasture (irrigated)	11,800	12,700	16,700	16,500

[a]Alfalfa hay figures for 1949 and 1954 are all hay figures and reflect all crops cut for hay.

[b]Alfalfa seed acreage reflects the total used to produce seed. In practice farmers have the alternative producing first crop alfalfa hay and second crop seed or alfalfa seed only.

Source: U. S. Census of Agriculture. Data adjusted to Basin boundaries.

Table 17.--Average crop yields per harvested acre, Beaver River Basin, census years, 1949-1964

Crop	Unit	1949	1954	1959	1964
Alfalfa hay[a]	Ton	2.2	2.3	2.6	3.0
Other tame hay[a]	Ton	---	---	1.5	2.0
Native hay[a]	Ton	---	---	1.2	1.7
Alfalfa seed	Cwt.	2.3	2.2	2.6	1.5
Barley	Bushel	39	45	48	56
Wheat (winter)[b]	Bushel	16	15	16	18
Wheat (spring)	Bushel	29	36	37	43
Oats	Bushel	47	43	43	42
Potatoes	Cwt.	204	226	201	171
Sugar beets	Ton	10	12	13	8
Corn silage	Ton	9	11	14	14

[a]Alfalfa hay figures for 1949 and 1954 are all hay figures and reflect all crops cut for hay.

[b]Low yield reflect influence of dryland acreage.

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

Table 18.--Total production of crops, Beaver River Basin, census years 1949-1964

Crop	Unit (1,000)	1949	1954	1959	1964
Alfalfa hay[a]	Tons	78.4	101.0	95.8	121.4
Other tame hay[a]	Tons	----	-----	3.6	6.0
Native hay[a]	Tons	----	-----	3.1	5.3
Alfalfa seed	Cwt.	19.4	20.1	16.7	13.2
Barley	Bushels	446.7	427.2	443.9	415.7
Wheat (winter)	Bushels	435.6	330.4	145.0	127.6
Wheat (spring)	Bushels	66.4	84.1	56.0	28.4
Oats	Bushels	100.1	73.9	27.5	41.7
Potatoes	Cwt.	523.1	621.0	443.5	547.2
Sugar beets	Tons	2.1	5.3	1.1	6.5
Corn silage	Tons	23.0	26.6	39.5	33.0

[a]Alfalfa hay production for 1949 and 1954 are all hay figures and represent all crops cut for hay in those years.

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

LIVESTOCK PRODUCTION

The numbers of cattle and calves, sheep and lambs, and hogs and pigs have varied over the 1949-1964 period. Cattle and calves increased in numbers from 1949 to 1954, decreased from 1954 to 1959 and again increased from 1959 to 1964. Sheep and lambs increased until 1954 and have decreased since that time. Hogs and pigs have had an up-and-down pattern. Milk cows and turkeys have consistently decreased in numbers over the period. Turkey production was discontinued in the area by 1964 (Table 19).

The number of cattle and calves sold from farms increased until 1959 and then decreased in 1964. A comparison of cattle inventories and sales would indicate that 1959 was an inventory reduction year and 1964 was an inventory building year. A similar comparison for sheep indicates that an inventory reduction started in 1959 and continued. Butterfat production has consistently decreased over the 1949-1964 period, while whole milk production increased until 1959 and then decreased in 1964 (Table 20).

Table 19.--Livestock on farms, Beaver River Basin, census years, 1949-1964

Type of Livestock	Year			
	1949	1954	1959	1964
	Number			
Cattle and calves	43,991	59,725	56,237	61,904
Milk cows	4,921	4,963	4,627	3,646
Sheep and lambs	85,553	118,401	106,513	93,048
Hogs and pigs	6,355	4,342	5,972	3,153
Turkeys	63,223	47,857	2,578	230

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

Table 20.--Amount of livestock and livestock products sold Beaver River Basin, census years, 1949-1964

Farm product	Unit	Year 1949	1954	1959	1964
Cattle and calves	Number	17,802	21,195	37,638	31,298
Butterfat	Pounds	41,039	28,188	11,675	8,510
Whole milk	1,000 Pounds	18,724	28,099	32,308	30,970
Sheep and lambs	Number	60,830	72,529	91,456	59,995
Wool shorn	1,000 Pounds	643.6	846.9	835.0	715.1
Hogs and pigs	Number	12,414	3,537	5,515	3,816

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

VALUE OF FARM PRODUCTS

Total value of farm products sold increased from $8.8 million in 1949 and 1954 to $12.2 million in 1959 and then decreased to $10.9 million in 1964 (Table 21). In 1949 and 1964, the Basin produced 6.8 percent of the State total of agricultural products. The value of farm products has remained stable in comparison to the State.

Table 21.--Value of farm products sold, Beaver River Basin, census years, 1949-1964

Product	Year 1949	1954	1959	1964
	---------1,000 Dollars--------			
Crops sold	3,294.4	3,374.8	2,777.3	3,855.4
Field crops	3,248.6	3,353.0	2,759.3	3,839.9
Vegetables	39.0	14.7	.7	.8
Fruits and nuts	6.0	4.1	3.6	3.0
Horticultural	.8	3.0	13.7	11.7
Livestock and livestock products	5,538.9	5,389.0	9,409.1	7,000.7
Dairy products	764.8	949.6	1,153.2	1,107.3
Poultry and poultry products	731.0	466.4	173.4	376.0
Livestock	4,043.1	3,973.0	8,082.5	5,517.4
Total value of sales	8,833.3	8,763.8	12,186.4	10,856.1

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

MISCELLANEOUS FARM CHARACTERISTICS

Changes in the major farm enterprises from 1949-1964 are shown in Table 22. During the 1949-1964 period the number of farms decreased by 29 percent. During the same period decreases registered by types of farms are as follows: field crop farms, 54 percent; poultry farms, 83 percent; dairy farms, 63 percent; livestock farms, 17 percent; general farms, 44 percent and miscellaneous and unclassified farms increased by 21 percent. These figures indicate that the trend is toward livestock farms.

Table 22.--Number of farms by major enterprise, Beaver River Basin, census years, 1949-1964

Type of enterprise	Year 1949	1954	1959	1964
	Number			
Field crop	84	66	42	47
Poultry	65	44	50	11
Dairy	237	230	113	88
Other livestock	346	325	377	288
General	275	284	115	154
Miscellaneous and unclassified	250	258	340	302
Total	1,257	1,207	1,037	890

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

The distribution of farms in 1964 by acreage size-groups are shown in Table 23. Forty-seven percent of the farms were smaller than 180 acres and 53 percent were larger than 180 acres. Twenty-eight percent of the farms were over 500 acres in size.

In 1964, there were 280 of the 890 farms that were part-time or part-retirement farms. These farms were not included in the classification of farms on the value of sales in 1964. The distribution of the remaining 601 farms by value of sales, show the following breakdown by classes: $50 to $2,499 sales, 9 percent; $2,500 to $4,999 sales, 22 percent; $5,000 to $9,999 sales, 24 percent; $10,000 to $19,999 sales, 21 percent; $20,000 to $39,999 sales, 14 percent and $40,000 and over sales, 10 percent.

Table 23.--Number of farms by acreage size-groups, Beaver River Basin, 1964

Size group	Farms	Portion of total farms
Acre	Number	Percent
Under 10	37	4.2
10-49	114	12.8
50-99	111	12.5
100-179	152	17.1
180-259	98	11.0
260-499	127	14.3
500 and more	251	28.1
Total	890	100.0

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

Table 24.---Number of farms by economic class and status, Beaver River Basin, 1964

Value of sales and status	Farms	Portion of total farms
	Number	Percent
Value of sales		
$50 to $2,499	56	6.3
$2,500 to $4,999	132	14.8
$5,000 to $9,999	146	16.4
$10,000 to $19,000	128	14.4
$20,000 to $39,999	82	9.2
$40,000 and over	57	6.4
Other status		
Part-time	203	22.8
Part-retirement	77	8.7
Abnormal	9	1.0
Total	890	100.0

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

VALUE OF LAND AND BUILDINGS

The value of land and buildings on farms during the 1949-1964 period were as follows: 1949, $28.1 million; 1954, $33.7 million; 1959, $40.9 million and 1964, $48.5 million. This represents an increase of 73 percent in the value of land and buildings on farms from 1949 to 1964. The value of the investment in land and buildings per farm during the same period increased by 144 percent. On a per-acre basis the increase was 41 percent. The variation in value and percentage increase is the result of changes in acres per farm and total acres in farms.

Table 25.--Value of land and buildings, Beaver River Basin, census years, 1949-1964

Year	Per Farm	Per Acre
	Dollar	Dollar
1949	22,343	32.57
1954	27,910	32.75
1959	39,459	35.41
1964	54,495	46.04

Source: U. S. Census of Agriculture. Data adjusted to reflect Basin boundaries.

GRAZING USE

In 1967, the estimated forage yield on rangelands within the Beaver River Basin was 393,400 animal unit months of grazing (Table 26). Of this total, 219,200 AUM's of grazing was on public domain lands, 36,000 AUM's on National Forest lands, 22,000 AUM's on state lands and 116,000 on private rangelands.

The trend for grazing use on public lands has been downward. In addition to this downward trend in authorized grazing, considerable non-use has occurred. Part of the non-use has been the result of voluntarily withholding livestock from these lands by stockmen and part is due to on-going improvement projects that require non-use for a period of time. In 1967, the non-use on National Forest and public domain was 25 percent of the authorized use.

The use of the grazing resource within the Basin is not all associated with grazing enterprises with base property in the area. Sheepmen with base property outside of the Basin have permits to use an estimated 32,500 AUM's of authorized grazing within the Basin.

Table 26.--Available grazing on National Forest, public domain, state lands and private lands, Beaver River Basin, 1967

Source	Amount
	Animal unit months
National forest	36,000
Public domain	219,200
State lands	22,200
Private lands	116,000
Total	393,400

GRAZING ENTERPRISES

Private and Federal grazing lands provide low-cost forage for livestock enterprises to be used in combination with hay, pasture, and grain grown on irrigated lands. These feed sources have provided ranchers with the resources for successful range livestock operations since early settlement.

There were 137 holders of forest permits for 5,540 cattle with authorized grazing of 25,280 animal unit months. Actual use during 1967 amounted to 5,256 cattle using 22,530 AUM's of forage. Sheepmen with forest permits totaled 34. Permit holders were authorized to run 21,745 sheep and use 12,500 animal unit months of forage. Actual use for sheep numbers and grazing was 82 percent of authorization. Overall, 85 percent of the authorized livestock were put on these lands and 87 percent of permitted grazing on National Forest lands in 1967 was actually used (Tables 27 and 28). The average forest permit was for 40 head of cattle and 185 animal unit months and 640 head of sheep to use 368 animal unit months of grazing.

Bureau of Land Management grazing permits are issued not only for federal lands but for State and private lands that are managed and grazed in conjunction with federal lands. There are 251 BLM permit holders with base property in the Basin. Of this total, 200 are for cattle and 51 for sheep. Authorized grazing on BLM permits totaled 181,565 animal unit months. Stockmen, holding BLM permits in 1967, could graze 18,760 cattle and 64,000 sheep. Actual use, however, totaled 14,660 cattle, 45,880 sheep and 131,330 animal unit months. Use compared to authorization was 73 percent of the livestock and 72 percent of the grazing (Tables 29 and 30). Actual grazing use

associated with State and private lands used in conjunction with federal lands was for 15,430 animal unit months in 1967. The average BLM permit was for 94 head of cattle using 629 animal unit months grazing and 1,255 sheep using 1,090 animal unit months of grazing.

Table 27.--Stockmen with National Forest cattle permits and base property in the Beaver River Basin, 1967

Subbasin	Permit Holders	Use: Permitted: Cattle	Use: Permitted: AUM's	Use: Actual: Cattle	Use: Actual: AUM's	Percent use is of Permits: Cattle	Percent use is of Permits: AUM's
	Number					Percent	
Fillmore	40	2,210	9,789	2,202	8,974	99.6	91.7
Beaver-Milford	32	1,471	6,597	1,443	5,682	98.1	86.1
Cedar-Parowan	56	1,368	4,418	1,140	3,578	83.3	80.1
Escalante Desert	9	491	4,476	471	4,296	95.6	96.0
Basin total	137	5,540	25,280	5,256	22,530	96.0	89.1

Source : Data provided by the U. S. Forest Service.

Table 28.--Sheepmen with National Forest sheep permits and base property in the Beaver River Basin, 1967

Subbasin	Permit Holders	Use: Permitted: Sheep	Use: Permitted: AUM's	Use: Actual: Sheep	Use: Actual: AUM's	Percent use is of permits: Sheep	Percent use is of permits: AUM's
	Number					Percent	
Fillmore	2	7,491	5,351	5,857	4,843	78.2	90.5
Beaver-Milford	--	-------	-----	------	-----	----	----
Cedar-Parowan	32	14,254	7,146	12,014	5,390	84.3	75.4
Escalante Desert	--	-------	-----	------	-----	----	----
Basin total	34	21,745	12,497	17,871	10,233	82.2	81.9

Source: Data provided by the U. S. Forest Service.

Table 29.--Stockmen with Bureau of Land Management cattle permits and base property in the Beaver River Basin, 1967

Subbasin	Permit Holders	Size of permits: Cattle	Size of permits: AUM's	Actual use: Cattle	Actual use: AUM's	Portion use is of permits: Cattle	Portion use is of permits: AUM's
	Number					Percent	
Fillmore	27	2,887	21,688	2,525	19,852	87.4	91.5
Beaver-Milford	84	5,974	29,414	5,390	27,324	90.2	92.8
Cedar-Parowan	63	7,554	56,995	4,849	35,066	64.1	61.5
Escalante Desert	26	2,342	17,752	1,900	14,136	81.1	79.6
Basin total	200	18,758	125,849	14,664	96,378	78.1	76.5

Source: Data provided by Bureau of Land Management.

Table 30.--Sheepmen with Bureau of Land Management sheep permits and base property in the Beaver River Basin, 1967

Subbasin	Permit Holders	Size of permits: Sheep	Size of permits: AUM's	Actual use: Sheep	Actual use: AUM's	Portion use is of permits: Sheep	Portion use is of permits: AUM's
	Number					Percent	
Fillmore	2	8,638	13,003	8,638	12,595	100.0	96.8
Beaver-Milford	--	------	------	------	------	-----	----
Cedar-Parowan	47	54,500	41,642	36,785	21,847	67.4	52.4
Escalante Desert	2	850	1,071	460	510	54.1	47.6
Basin total	51	63,988	55,716	45,883	34,952	71.7	62.7

Source: Data provided by the Bureau of Land Management.

CHAPTER III

PRESENT AND FUTURE NEEDS

The designation on "OBERS" projections has reference to a set of economic projections issued by the Office of Business Economics, U. S. Department of Commerce and the Economic Research Service, U. S. Department of Agriculture. OBE prepared projections on population, employment, personal income and earnings. ERS provided projections for agricultural commodities. Projections were prepared for all States, water resource regions and subregions within the United States. The purpose of these projections was to provide an overall base for use in water and related land resource development planning studies. Projections were provided for the years 1965 (base year), 1980, 2000 and 2020.

The historical and base period data for each area are shown by time series for population, employment, income and production. Projections are intended to measure the same economic characteristics at selected points in the future. The projections serve the following purposes: (1) provide data needed to establish past and current relationships between resource use and economic activity; (2) to provide a framework to identify economic strengths and weaknesses; (3) to furnish an analytical base from which to prepare projections of resource impacts and needs and (4) to provide a base from which economic consequences of alternative plans could be measured.

Projections of economic activities are not predictions of future levels of production, but are approximations of what would occur if a given set of assumptions are met. The OBERS projections should be viewed as a baseline projection which has a national base where regional projections sum to national totals. They should not be viewed as a quota of production, but rather as a level of economic activity associated with an extension of historical trends with consideration for an area's comparative advantage and specialization in the production of commodities.

Agricultural production in the United States was determined by projecting future national requirements for various commodities based on expected population growth, gross national product, per capita income, consumer preferences and agricultural imports and exports. National production was disaggregated to States, major river basins and subregions within river basins. Disaggregation was accomplished using the following steps: (1) projected national output was distributed among States by extending trends from a historical base of 1947

to 1970; (2) State totals were transformed into subareas and regions using historical percentage distribution among subareas (agricultural census years 1949, 1954, 1959 and 1964) using agricultural census data; (3) 1980 projections were developed by extending trends using four census points and (4) field review and adjustment of percentage distribution.

Distribution of projected national production among States was adjusted to reflect available agricultural land base. Land requirements were compared with land availability and adjustments made to States with indicated shortage of agricultural land and compensatory adjustments to States with surplus agricultural lands.

Projections for the Beaver River Basin were accomplished using the same procedures employed to disaggregate national projections to States and subareas. The Beaver River Basin in addition to the Sevier River Basin form the Sevier Lake Subregion which is a part of the Great Basin Water Resource Region. Disaggregated national projections were available for the Sevier Lake Subregion. Historical agricultural data and trends were established for the Beaver River Basin and percentage distribution procedures used to disaggregate Sevier Lake Subregion projections to the Beaver River Basin. Similar procedures were used in making projections of population, income and employment.

POPULATION

Population is projected to remain about the present level until 1980 and increase after that period (Table 31). In 1965, there were 18,435 people residing in the Basin; the number is projected to be 18,500 by 1980; 20,500 in 2000 and 23,000 by 2020.

Table 31.--Projected population by subbasins, Beaver River Basin

Area	1965 base year	1980	2000	2020
	Number			
Fillmore	2,400	1,700	1,600	1,500
Beaver-Milford	4,065	3,400	3,200	3,000
Cedar-Parowan	10,500	12,000	14,500	17,500
Escalante Desert	1,470	1,400	1,200	1,000
Total	18,435	18,500	20,500	23,000

Source: OBERS projections adjusted to the Basin

Past and projected population distribution by subbasins vary considerably (Table 32). The number of people in the Cedar-Parowan Subbasin has been increasing and this trend is expected to continue. The population in the Fillmore and Beaver-Milford Subbasins has been decreasing and these trends are projected to continue. The trend in the Escalante-Desert Subbasin has been increasing, but is expected to decrease in the future. Population increases in the Escalante Desert area have been related to ground water developments. Restraints have been placed on ground water pumping which has limited agricultural activities.

Table 32.--Past and projected population distribution, Beaver River Basin, selected years, 1940-2020

Area	1940	1965 base year	1980	2000	2020
	Number				
Fillmore	20.0	13.0	9.0	8.0	6.5
Beaver-Milford	28.0	22.0	18.0	15.5	13.0
Cedar-Parowan	46.0	57.0	65.0	70.5	76.0
Escalante Desert	6.0	8.0	8.0	6.0	4.5
Basin total	100.0	100.0	100.0	100.0	100.0

Source: OBERS projections adjusted to the Basin.

EMPLOYMENT

Employment projections for the area are presented in Table 33 for the 1965 base year, 1980, 2000 and 2020. The employment is projected to increase from 6,750 in 1965 to 9,200 in 2020. Employment projections reflect slight increases over time in the work participation ratio. Employment population ratios were projected using historical trends established during the 1940-1960 period. In 1965, the work participation ratio was 36.5 percent and is projected to increase to 38.0 percent, 39.0 percent and 40.0 percent by 1980, 2000 and 2020, respectively. These increases reflect the general assumption in the OBERS projections that regional employment population ratios will tend to move toward the national ratio.

Within long-term employment projections, the forecasts for the different sectors vary significantly. In general terms, employment in the service and manufacturing sectors is projected to increase, with manufacturing increasing at the faster rate. Agriculture and mining sectors are projected to decrease in employment. Agriculture is projected to continue its long term decline. Future changes in both the

structure and productivity within agriculture will reduce the number of people employed in this sector. The agricultural work force is projected to decrease from 17 percent of the total employment in 1965 to 6.3 percent by 2020. Mining employment, also will be affected by expected productivity advances.

Table 33.--Projected employment by sector, Beaver River Basin

Sector	1965 base year	1980	2000	2020
	--------Number--------			
Agriculture & forestry	1,150	800	725	575
Mining	550	500	460	425
Manufacturing	300	600	940	1,500
Other	4,750	5,300	5,875	6,700
Total	6,750	7,030	8,000	9,200

Source: OBERS projections adjusted to the Basin.

PERSONAL INCOME

Projected values for personal income provide a broad framework for measuring future economic expansion. Overall, the projections of personal income are tied to the national projections of personal income with area differences recognized. The projections used, therefore, reflect both the national and area trends.

Projected personal income, per capita income and earnings per worker projections are shown in Table 34. Total personal income is projected to increase from $37.8 million to $220.8 million in 2020. Per capita income during the 1965 base year was $2,051 and is projected to increase to $2,810 by 1980 and $9,600 in 2020. Earnings per worker are projected to increase from $4,780 in the 1965 base year to $19,488 in 2020.

When compared to the United States averages, the Basin shows the following projected per capita income deficits: 1965, $555; 1980, $1,405; 2000, $2,418 and in 2020, $3,122.

Table 34.--Projected personal income, per capita income and earnings per worker, Beaver River Basin, 1965 base year, 1980, 2000, 2020[a]

Item	Unit	1965 base year	1980	2000	2020
	1,000				
Personal income	dollars	37,812	51,985	100,901	220,800
Per capita income	dollars	2,051	2,810	4,922	9,600
Earnings per worker	dollars	4,780	6,013	9,992	19,488

[a]Projections in terms of 1965 dollars.

Source: OBERS projections adjusted to the Basin.

AGRICULTURAL PRODUCTION

BACKGROUND AND PROCEDURES

The August, 1967 OBERS agricultural projections were made using index numbers. The indices were constructed using base period prices as weights applied to physical volume of projected agricultural production.

Later, commodity projections were furnished for water resource regions. Commodity projections for the Sevier Lake Subregion were used in making commodity projections for the Beaver River Basin. The general procedure used was to reconstruct the Sevier Lake Subregion and the Beaver River Basin production for each commodity for the 1949-1964 census years. Base period production of agricultural commodities in the Beaver River Basin was determined on the basis of their share of the Sevier Lake Subregion base period production and projected using the same proportion.

Some variations of the basic assumptions, used in making the Sevier Lake Subregion projections were assumed in projecting crop yields and land use in the Beaver River Basin. These variations involved were with regard to water quality and quantity available per irrigated acre during the projection period. The first assumption was that water quality would not worsen during the projection period. Indications are that the quality of ground water used in the Beaver River Basin is decreasing. Research by Stewart and Pincock[1] on the impacts of water quality on agricultural production was used in estimating the effects of decreasing ground water quality on crop yields. The second assumption was that

[1]Stewart, Clyde E., and Pincock, Glade M., "Impacts of Water Quality on the Agricultural Industry in the Colorado River Basin," Economic Research Service, January, 1968.

water depletions per irrigated acre would increase during the projection period. Water depletions per irrigated acre used in making the Sevier Lake Subregion projections were as follows: 1965, 1.85 acre feet per acre; 1980, 1.90 acre feet per acre; 2000, 1.95 acre feet per acre and in 2020, 2.00 acre feet per acre. It was assumed in the Beaver River Basin projections that the water depletions per irrigated acre would remain the same during the projection period.

AGRICULTURAL PRODUCTION

Projections for crop production livestock and livestock products are shown in Table 35. These projections are consistent with OBERS projections for the Sevier Subregion and the Great Basin Water Resource Region. The projections reflect the average level of management and inputs. The total production projections reflect the expected future use of inputs, such as water, fertilizer, insecticide, herbicides, cultural practices and the adoption of new varieties.

Feeding efficiencies and feed requirements for livestock and livestock products are the same as used in the Sevier Lake Subregion projections. These projections reflect changes in the composition of rations, technology and management.

Feed grain production is projected to increase from 441,000 bushels in 1965 to 834,700 bushels in 2020. Wheat production during the same period is expected to increase 156,100 bushels to 251,000 bushels. Grain production includes the use of both dry land and irrigated land.

Hay and forage production is expected to increase in all categories. Hay and corn silage are projected to increase by 38 percent from 1965 to 2020. Pasture is expected to increase by 47 percent and range forage by 42 percent, during the same period. Alfalfa seed production was projected to increase at the same rate as alfalfa hay production. Sugar beet production for the target years is projected as follows: 1965, 8,000 tons; 1980, 16,800 tons; 2000, 26,100 tons and 2020, 37,900 tons. Potato production is projected to decrease from 1965 to 1980 and then increase from 1980 to 2020.

The production of livestock and livestock products are all projected to increase from 1965 to 2020. The percentage increases are as follows: beef and veal, 200 percent; pork, 25 percent; lamb and mutton, 79 percent and whole milk, 111 percent. Pork production is the only commodity that is projected to decrease during any of the target years.

Table 35.--Projected agricultural production by commodity and product groups, Beaver River Basin

Commodity	Unit (1,000)	1965 base year	1980	2000	2020
Feed grains					
Oats	Bu.	42.0	44.1	52.1	58.0
Barley	Bu.	399.0	504.9	598.5	776.7
Hay and forage					
Hay	Tons	129.5	136.2	160.6	178.7
Silage	Tons	33.6	35.2	41.6	46.4
Pasture	AUM	65.6	79.6	91.6	96.1
Range	AUM	272.6	287.4	352.6	386.7
Cash crops					
Alfalfa seed	Cwt.	13.5	14.2	16.8	18.6
Wheat	Bu.	156.1	192.9	217.6	251.0
Sugar beets	Tons	8.0	16.8	26.1	37.9
Potatoes	Cwt.	560.0	500.1	658.5	863.1
Meat Animals[a]					
Beef and veal	Lbs.	15,385	26,343	35,072	46,022
Pork	Lbs.	1,395	1,027	1,343	1,737
Lamb & mutton	Lbs.	5,538	5,692	7,545	9,892
Dairy products					
Whole milk	Lbs.	32,100	40,197	52,365	67,600

[a]Liveweight basis.

Source: OBERS projections adjusted to the Basin.

CROP YIELDS

Crop yield projections are needed to determine the future land and water resource use pattern necessary to produce projected agricultural production. The land and water use pattern has changed in the past and is projected to change in the future.

The crop yield projections represent what could be expected with average management and available resources for each target year. Some basic assumptions are built into the yield projections. It was assumed that effective pesticides and herbicides would be available to control insects and weeds. Yields also reflect increased fertilizer use.

Some variations in basic assumptions were used in yield projections for the Beaver River Basin compared to the Sevier Lake Subregion projections. The Sevier Lake Subregion projections assumed that water quality would not worsen during the projection period and that water depletions would increase per irrigated acre. In the Beaver River Basin projections it was assumed that ground water used for irrigation would continue to decrease in quality and that irrigation water depletions per irrigated acre would remain the same. Table 36 shows the crop yield projection indices for the two areas.

Crop yield projections are shown in Table 37. Yield for the 1965 base year are similar to yields reported in the 1964 Agricultural Census. Projected yield increases vary by individual crops. Large yield increases are projected for grain crops, medium increases for potatoes and corn silage and smaller increases for forage crops and sugar beets.

Table 36.--Crop yield indices for Sevier Lake Subregion and Beaver River Basin, 1980, 2000 and 2020

	Sevier Lake Subregion				Beaver River Basin			
Crops	1965	1980	2000	2020	1965	1980	2000	2020-
	Percentage							
Irrigated land								
Alfalfa hay	100	120	140	160	100	112	126	140
Other tame hay	100	120	140	160	100	112	126	140
Native hay	100	120	140	160	100	112	126	140
Pasture	100	120	132	136	100	112	119	119
Alfalfa seed	100	120	140	160	100	112	126	140
Corn silage	100	123	153	180	100	115	138	157
Barley	100	120	157	185	100	115	148	170
Wheat	100	162	200	225	100	154	186	205
Oats	100	121	158	187	100	115	147	170
Potatoes	100	122	152	179	100	114	137	156
Sugar beets	100	115	130	146	100	110	122	134
Non-irrigated								
Barley	100	114	129	143	100	114	129	143
Wheat	100	114	133	143	100	114	133	143

Source: Economic Base and Projections Appendix IV, Great Basin Region Comprehensive Framework Study. Data adjusted to fit Basin conditions.

Table 37.--Projected average crop yield per harvested acre, Beaver River Basin

Crop	Unit	1965 Base year[a]	1980	2000	2020
Irrigated crops					
Alfalfa hay	Ton	3.0	3.4	3.8	4.2
Other tame hay	Ton	2.0	2.2	2.5	2.8
Native hay	Ton	1.7	1.9	2.1	2.4
Pasture	AUM	4.0	4.5	4.8	4.8
Alfalfa seed	Cwt.	1.5	1.7	1.9	2.1
Corn silage	Ton	14.0	16.1	19.3	22.0
Barley	Bu.	56.0	64.0	83.0	95.0
Wheat	Bu.	43.0	66.0	80.0	88.0
Oats	Bu.	42.0	48.0	63.0	71.0
Potatoes	Cwt.	175.0	200.0	240.0	273.0
Sugar beets	Ton	10.0	11.0	12.2	13.4
Non-irrigated crops					
Wheat	Bu.	18.0	20.5	24.0	26.0
Barley	Bu.	35.0	40.0	45.0	50.0

[a]Similar to yields reported in the 1964 Agricultural Census.

Source: OBERS projections adjusted to Basin conditions.

LAND USE

Projected acreage which would be required to produce the quantity of crops distributed to the Beaver River Basin using OBERS projections are shown in Table 38. The figures are for harvest acreages only. Idle or unused land is not included. There are considerable acreages of cropland and range lands that are idle periodically. The projections do reflect some double cropping. It is assumed that one-half of the alfalfa seed was produced on acreages which a first cutting of alfalfa was taken. Aftermath grazing was included on all croplands.

The acreage of harvested cropland and irrigated pasture lands required to produce the OBERS production distribution show that total land requirements will decrease in 1980 and 2000. The 2020 requirements indicate that 3,000 additional acres above the 1965 base year acreage will be needed. Sugar beet and pasture acreages are the only categories that show consistent increases over the projection period.

Water consumptive use requirements to meet projected crop production will parallel irrigated cropland requirements. Irrigation water requirements would decrease in the 1980 and 2000 target years. A small increase in irrigation water would be required in 2020.

Table 38.--Projected cropland harvested, Beaver River Basin

Item	1965 base year[b]	1980	2000	2020
	--------------1,000 acres--------------			
Irrigated land				
Alfalfa hay[a]	41.0	38.6	40.8	41.1
Other tame hay	3.0	2.0	2.0	2.0
Native hay	.3	.3	.3	.3
Alfalfa seed[a]	9.0	8.4	8.8	8.9
Corn silage	2.4	2.2	2.2	2.1
Feed grains	7.5	6.0	4.6	6.8
Wheat	.7	----	----	----
Sugar beets	.8	1.5	2.1	2.8
Potatoes	3.2	2.5	2.9	3.2
All other	.3	.3	.3	.3
Irrigated cropland harvested	63.7	57.6	59.6	63.1
Permanent pasture	6.0	6.0	6.0	6.0
Other pasture	10.4	11.7	13.1	14.0
Total irrigated land	80.1	75.3	78.7	83.1
Dryland harvested				
Wheat	7.0	9.4	9.1	9.7
Barley	1.0	4.5	4.8	4.2
Other	5.9	----	----	----
Total dryland harvested	13.9	13.9	13.9	13.9

[a] Alfalfa seed acreage reflects the total used to produce seed. In practice only half is used for seed and half for alfalfa hay and seed.

Source: OBERS projections adjusted to Basin conditions.

[b] Similar to harvested acreage reported in the 1964 Agricultural Census.

ADEQUACY OF FEED AND FORAGE CROPS

Farmers in the past have been very successful in increasing both total production and production rates. Both crop yields and livestock production per unit of input have been increasing. Table 39 shows the livestock feeding efficiencies used in evaluating the ability of land and water resource base to support the projected livestock economy. The total digestible nutrients per unit of output is projected to decrease in all categories. In addition, the components of the various livestock rations are projected to change over the evaluation period. In general terms, grain and protein supplements are projected to replace some hay and forage in livestock rations (Table 40).

Table 39.--Projected feeding efficiencies for livestock, Beaver River Basin

Items	1965	1980	2000	2020
	Pounds TND[a] per pound output			
Beef				
Cow-calf	14.0	12.1	11.0	10.0
Feed lot	6.5	6.3	6.0	5.5
Pork	3.0	2.8	2.5	2.3
Lamb and mutton	11.6	9.8	8.0	7.5
Milk	1.16	1.05	.95	.85

[a]Total digestible nutrients.

Source: Economic Base and Projections, Appendix IV, Great Basin Region Comprehensive Framework Study.

The total feed needed in all categories is to increase. The percentage increase from 1965 base year to 2020 by categories is as follows: range forage, 57 percent; hay and pasture, 54 percent and 230 percent; corn silage, 192 percent and protein supplement, 79 percent.

The surplus and deficit of projected feed production compared to projected livestock needs are shown in Table 42. In 1965, the Basin produced a surplus of hay and had a deficit in feed grains. The range resources were essentially in balance. Projected figures indicate that hay will continue to be surplus and there will be deficits in range forage, corn silage and feed grains.

Table 40.--Projected percentage of total digestible nutrients in feed ration by source of feed, Beaver River Basin

Livestock category	Source of total digestible nutrients	Percent of total			
		1965 base year	1980	2000	2020
Beef, cow-calf	Hay and forage	98	97	96	96
	Feed grains	1	2	3	3
	Protein supplement	1	1	1	1
Beef, feedlot	Hay and forage	51	47	44	40
	Feed grains	39	45	50	55
	Protein supplement	10	8	6	5
Pork	Hay and forage	12	10	7	7
	Feed grains	78	82	87	87
	Protein supplement	10	8	66	6
Lamb and mutton	Hay and forage	100	94	92	90
	Feed grains	---	4	6	7
	Protein supplement	---	2	2	3
Milk	Hay and forage	78	72	67	60
	Feed grains	18	23	28	33
	Protein supplement	4	5	5	7

Source: Economic Base and Projections, Appendix IV, Great Basin Region Comprehensive Framework Study.

Table 41.--Projected feed requirements for livestock, Beaver River Basin

Type of Feed	Unit	1965 base year	1980	2000	2020
Range forage	AUM	276,322	322,815	380,147	434,594
Hay and pasture (hay equivalent)	Ton	92,429	112,526	123,366	142,211
Feed grain	Bu.	922,310	1,618,859	2,302,064	3,043,495
Corn silage	Ton	32,466	52,343	74,544	94,690
Protein supplement	Cwt.	131,624	183,018	188,967	235,854

Table 42.--Projected surplus (+) or deficit (-) of feed to meet livestock needs, Beaver River Basin

Type of Feed	Unit	1965 base year	1980	2000	2020
Range forage	AUM	-4,122	-35,415	-27,547	-47,894
Hay and pasture (hay equivalent)	Ton	+59,384	+50,748	+68,390	+69,176
Feed grain[a]	Bu.	-403,260	-973,409	-1,532,664	-2,083,295
Corn silage	Ton	+1,134	-17,043	-32,944	-48,290

[a]Fifty percent of wheat is assumed used for feed grain.

Land use changes necessary to bring crop production and livestock enterprises into balance are shown in Table 43. To produce all the livestock feed needs, except protein supplement, in the Basin would require the following increased irrigated land use: 1965 base year, 52,135 acres; 1980, 138,228 acres; 2000, 168,368 acres and in 2020, 205,019 acres.

There are enough arable lands to produce livestock feed needs, but there is not enough irrigation water available. Present water use is in excess of the annual water yield. Ground water reservoirs are presently being mined to support the present agricultural economy. Increased irrigation water use would increase the ground water mining rate.

Table 43.--Projected land use change necessary to bring crop production and livestock feed needs into balance, Beaver River Basin

Type of feed	Unit	1965 base year	1980	2000	2020
		acre			
Range forage	Acre	+41,220	+354,150	+275,470	+478,940
Hay and pasture (hay equivalent)	Acre	-19,794	-14,926	-17,997	-16,470
Feed grain	Acre	+72,010	+152,095	+184,658	+219,294
Corn silage	Acre	-81	+1,059	+1,707	+2,195
Total (irrigated land)	Acre	+52,135	+138,228	+168,368	+205,019

ALTERNATIVE CROP PROJECTIONS

The OBERS baseline projections used in this report were developed using agricultural census data. Land use and farm enterprise surveys were conducted to determine the agricultural base and gather information on farm inputs and outputs as part of the Beaver River Basin study. Considerable difference existed between the agricultural base and crop yields reported in the census and figures established by the survey.

Alternative projections were developed that reflect the base acreages and crop yields established in the land use and farm surveys. Livestock numbers and production rates used in OBERS projections were also used in the alternative projections. The same basic assumptions on management, inputs and technological changes were assumed for both sets of projections, only the base year acreages and crop yields were different.

Projections on crop production, crop yields and crop acreages are shown in Tables 44, 45 and 46. These figures represent the agricultural base used in evaluating the present and potential opportunities in the Beaver River Basin.

Table 44.--Projected agricultural production by commodity and product groups, Beaver River Basin

Commodity	Unit (1,000)	1965 base year[a]	1980	2000	2020
Feed grains					
Oats	Bu.	143.0	150.2	177.3	197.3
Barley	Bu.	1,289.5	1,631.2	1,934.3	2,509.4
Hay and forage					
Hay	Ton	195.3	205.3	242.2	269.3
Silage	Ton	68.8	72.2	85.2	94.9
Pasture	AUM	76.7	93.0	107.1	112.3
Range	AUM	393.4	414.6	508.7	557.8
Cash crops					
Alfalfa seed	Cwt.	20.0	21.0	24.9	27.5
Wheat	Bu.	216.0	266.8	200.9	247.1
Potatoes	Cwt.	1,080.0	964.4	1,269.0	1,664.3

[a]Based on a 1965 land use survey and a 1967 crop yield survey conducted within the Basin.

Source: OBERS projections adjusted to Basin conditions.

Table 45.--Projected average crop yield[a] per harvested acre, Beaver River Basin, 1965 base year, 1980, 2000 and 2020

Crop	Unit	1965 base year	1980	2000	2020
Irrigated crops					
Alfalfa hay	Ton	3.8	4.3	4.8	5.3
Other tame hay	Ton	2.0	2.2	2.5	2.8
Native hay	Ton	1.7	1.9	2.1	2.4
Pasture	AUM	6.0	6.8	7.2	7.2
Alfalfa seed	Cwt.	2.0	2.3	2.5	2.8
Corn silage	Ton	18.6	21.4	25.6	29.2
Barley	Bu.	75.0	86.0	111.0	127.0
Wheat	Bu.	72.0	82.0	106.0	122.0
Potatoes	Cwt.	180.0	206.0	247.0	280.0
Non-irrigated crops					
Barley	Bu.	35.0	40.0	45.0	50.0
Wheat	Bu.	18.0	20.5	24.0	26.0
Pasture	AUM	1.0	1.2	1.35	1.5

[a]Base year yields are average yields reported by farmers in 1967 farm survey conducted by Economic Research Service.

Source: OBERS projections adjusted to Basin conditions.

Table 46.--Projected cropland harvested, Beaver River Basin, 1965 base year, 1980, 2000 and 2020

Item	1965[a] base year	1980	2000	2020
	--------------------	1,000 acres	--------	
Irrigated land				
Alfalfa hay[b]	51.4	47.1	49.8	50.2
Other tame hay	1.0	1.0	1.0	1.0
Native hay	.3	.3	.3	.3
Alfalfa seed[b]	10.0	9.1	9.6	9.8
Corn silage	3.7	3.4	3.3	3.3
Feed grains	19.1	20.7	19.0	21.3
Wheat	1.2	----	----	----
Potatoes	6.0	4.7	5.1	5.9
All other	.3	.3	.3	.3
Cropland harvested	88.0	82.1	83.6	87.2
Permanent pasture	3.8	3.8	3.8	3.8
Other pasture	6.4	7.2	8.1	8.6
Total irrigated land	98.2	93.1	95.5	99.6
Dryland Harvested				
Wheat	7.0	13.0	12.5	13.4
Barley	11.6	----	----	----
Pasture	15.5	30.7	30.7	30.7
Total dryland harvested	24.1	43.7	43.2	44.1

[a]Crop acreage and crop distribution shown for 1965 are those identified by a land use survey conducted by Soil Conservation Service.

[b]Alfalfa seed acreage reflects the acreage used to produce seed. In practice, only half is used for seed and half for first crop alfalfa hay and second crop alfalfa seed.

Source: OBERS projections adjusted to Basin conditions.

The surplus or deficit of projected livestock feed production compared to projected livestock feed needs are shown in Table 47. In the 1965 base year, the Basin produced a surplus in all feed categories when compared to livestock feed needs. This same condition is projected to exist in 1980. By 2000 and 2020 feed grains needed to support the livestock economy would be in short supply. During these same periods all the other available livestock feeds would continue to be in excess to livestock feed requirements.

Table 47.--Projected surplus (+) or deficit (-) of feed to meet livestock needs, Beaver River Basin

Type of Feed	Unit	1965 base year	1980	2000	2020
Range forage	AUM	+117,078	+91,785	+128,553	+123,206
Hay and pasture (hay equivalent)	Ton	+129,000	+124,400	+155,200	+165,200
Feed grain	Bu.	+623,000	+295,900	-40,000	-163,200
Corn silage	Ton	+36,334	+19,857	+10,656	+210

Land use changes necessary to bring crop production and livestock enterprises into balance are shown in Table 48. The crop acreage changes required to establish a crop production livestock feed balance are as follows: 1965 base year, -44,300 acres; 1980 -33,200 acres; 2000, -29,100 acres and 2020, -18,300 acres. These figures indicate that the area would have to increase livestock production to a level above projected demand to use available feed or continue to export feed, if the present crop acreage is maintained in the future.

Table 48.--Projected land use changes necessary to bring crop production and livestock feed requirements into balance, Beaver River Basin

Type of Feed	Unit	1965 base year	1980	2000	2020
Range forage	Acre	-1,170,780	-917,850	-1,285,530	-1,232,060
Hay and pasture (hay equivalent)	Acre	-34,000	-28,900	-32,300	-31,200
Feed grain	Acre	-8,300	-3,400	+3,600	+12,900
Corn silage	Acre	-2,000	-900	-400	-------
Total irrigated land	Acre	-44,300	-33,200	-29,100	-18,300

CHAPTER IV

IMPACTS OF RESOURCE USE CHANGES

PROCEDURES

An irrigation simulation model was used in the Beaver River Basin study. The model was formulated to distribute the available irrigation water supply to irrigated crops and determine area net crop income associated with this supply. This operation required consideration of the entire process, which is a function of the hydrologic system and the related economic production functions. Application of this technique requires the synthesis of fundamental mathematical relationships for the hydrologic and economic processes into one system. A schematic diagram of this hydrologic-economic model is shown in Figure 1.

The link between the hydrologic and economic processes within the model is the individual crop production functions. These functions represent the relationship between actual evapotranspiration of soil moisture on the hydrologic side and crop yields on the economic side. Consequences of various water supply alternatives, under constraining assumptions were then traced through time.

A base period approach was used in evaluating yearly variations in water use. The period used was 1956-1965. The program was run for each year in the base period with water use and net crop income simulated for each year. The level of technology, crop yields, cropping pattern and water use relationships assumed was those levels existing in 1965. Input and output prices used in the analysis were normalized price projections made by the U. S. Department of Agriculture. Water use and net crop income for each year in the base period represents only one point on an n-dimensional response surface represented by the model. With all variables except available water and net crop income held constant, each year in the base period represents a change in net crop income associated with available irrigation water. A series of 10 points on the production possibility surface are represented using the base period approach and are assumed to graphically establish the basic relationship between water use and are net crop income.

Three time frames were evaluated in the study. These time frames were the present situation referred to as the 1965 base period and projected 1980 and 2020 situations. A with-without approach was used in the projected 1980 and 2020 situations. Within each projected situation, three water management alternatives were evaluated. These

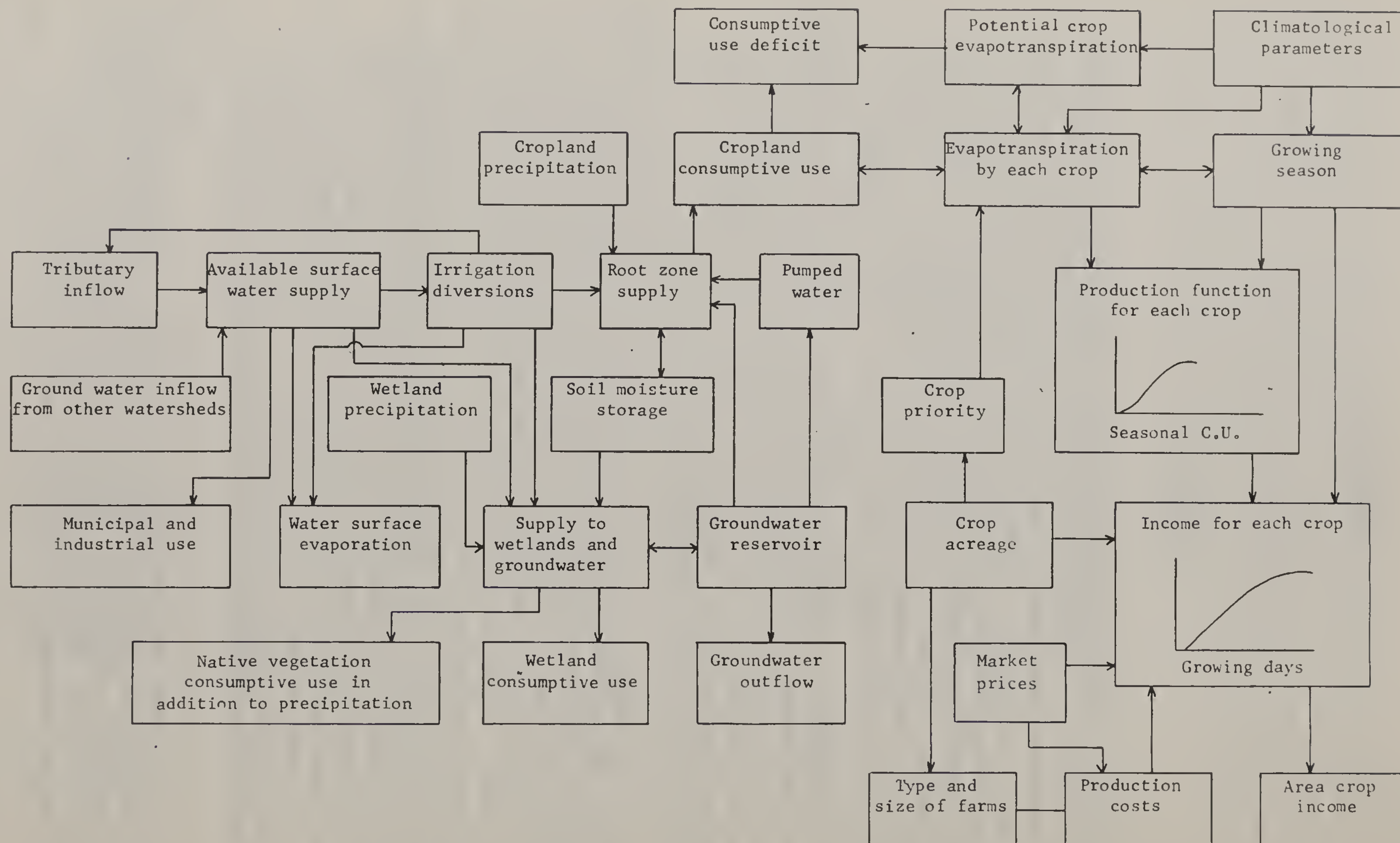

Figure 1.- Schematic diagram of hydrologic economic model, Beaver River Basin

alternatives include the "without development" situation where the present or 1965 water use coefficients were used and the "with development" situations where water use coefficients were changed to represent projected efficiency gains through going resource management programs and acceleration of these going programs. Changes in the level of technology, crop yields, cropping pattern, farm size and input-output prices were projected to the 1980 and 2020 time frames. Within each time frame all variables within the model except water use coefficients were held constant. Water use coefficients were varied to evaluate the impacts of water management alternatives. Each alternative was then evaluated using the base period approach.

Several management alternatives were evaluated using this technique. The time frame and resource management alternatives evaluated are as follows:

(1) Present (1965) physical and economic relationships.
(2) Projected 1980 "with" going resource development programs (projected 1980 water use coefficients resulting from going programs and projected 1980 physical and economic relationships).
(3) Projected 1980 "with" acceleration of going resource development programs (projected 1980 water use coefficients resulting from acceleration of going programs and projected 1980 physical and economic relationships).
(4) Projected 2020 "with" going resource development programs (projected 2020 water use coefficients resulting from going programs and projected 2020 physical and economic relationships).
(5) Projected 2020 "with" acceleration of going resource development programs (projected 2020 water use coefficients resulting from acceleration of going programs and projected 2020 physical and economic relationships).

Comparisons and conclusions were drawn from the above situations. It was assumed that when one or more variables were held constant between different situations, while others were varied, that the resulting income changes were all attributed the ones that were allowed to change. For example, water use coefficients were held constant while technological, market and input-output variables were changed between the 1965, 1980, and 2020 time frames. The resulting income changes between time periods were all attributed the variables that were allowed to change. Within the 1980 and 2020 time frames, water use

coefficients were varied while other variables were held constant and income and consumptive use of water were attributed to resource development programs.

Impacts of resource development were identified in terms of area income and water used by irrigated crops. Additional impacts were identified as they relate to the total available water resource, total water use and ground-water levels.

RESOURCE AVAILABILITY

LAND

The area contains 8,191 square miles and includes a variety of uses. Cultivated crops and livestock grazing are the main agricultural uses. Only 20.4 percent of the area is in private ownership and management. The remaining part is managed by public agencies. A large part of the public lands are used by livestockmen for grazing purposes.

There are 195,500 acres of cropland with irrigated cropland totaling 115,110 acres and non-irrigated cropland 80,390 acres (Table 49). Alfalfa, small grains, grass hay and pasture, potatoes and corn for silage are the most important crops grown on irrigated lands in that order.

A large portion of both the irrigated and non-irrigated cropland is presently idle. Idle acreages include 16,960 acres of irrigated cropland and 25,200 acres of non-irrigated cropland. Expansion of the present irrigated agricultural economy would include those presently idle acres within the irrigated cropland area first, since irrigation distribution facilities are already available to these acres.

The type of irrigation available to cropland areas vary. Some areas have only surface water available, some have well water, while other areas have a combination of both.

The present cropping pattern is projected to remain essentially the same. The present rotation of alfalfa, small grains, corn and potatoes is projected to continue in the future, except the years of alfalfa in the rotation are projected to decrease from 8 years in 1965 to 7 years in 1980 and 6 years in 2020.

Table 49.--Private land use, Beaver River Basin, 1965

Use	Subbasin[a]				
	Fillmore	Beaver-Milford	Cedar-Parowan	Escalante Desert	Basin
	Acre	Acre	Acre	Acre	Acre
Irrigated cropland					
Corn	600	840	1,060	1,190	3,690
Potatoes	100	670	40	5,200	6,010
Sugar beets	-	-	-	190	190
Orchard	10	20	-	10	40
Small grains	6,490	3,500	4,330	7,110	21,430
Alfalfa	16,160	16,200	12,960	10,970	56,290
Pasture	2,470	5,420	2,040	570	10,500
Idle	3,370	5,900	4,380	3,310	16,960
Total	29,200	32,550	24,810	28,550	115,110
Nonirrigated cropland					
Small grains	7,980	10	440	170	8,600
Grass	11,470	950	2,240	860	15,520
Fallow	11,010	690	2,910	1,150	15,760
Conservation use	6,120	870	8,260	60	15,310
Idle	5,350	3,960	8,470	7,420	25,200
Total	41,930	6,480	22,320	9,660	80,390
Total cropland	71,130	39,030	47,130	38,210	195,500
Rangeland					
Range	100,790	162,370	162,890	365,370	791,420
Forest	2,100	1,070	30,030	540	33,740
Total	102,890	163,440	192,920	365,910	825,160
Other	7,960	6,540	11,010	6,550	32,060
Grand Total	181,980	209,010	251,060	410,670	1,052,720

[a]Does not include the Sevier Lake Subbasin which contains 14,060 acres.

Source: Present and Projected Resource Use and Management, Appendix II, Beaver River Basin, June 1973.

WATER

The available water supply and its use were inventoried and evaluated using 12 water budget areas.[1] These 12 were consolidated in four subbasins and into a basin summary for use in this section. Budgets were developed for each year 1956-1965.[2]

The average annual water supply was 264,880 acre feet during the 1956-1965 base period (Figure 2). The annual water supply varied from a low of 161,280 acre feet during 1959 to a high of 393,000 acre feet in 1957. Total available water supply includes ground and surface water inflows into water budget areas from tributary areas, inflows from outside the Basin and precipitation on irrigated croplands.

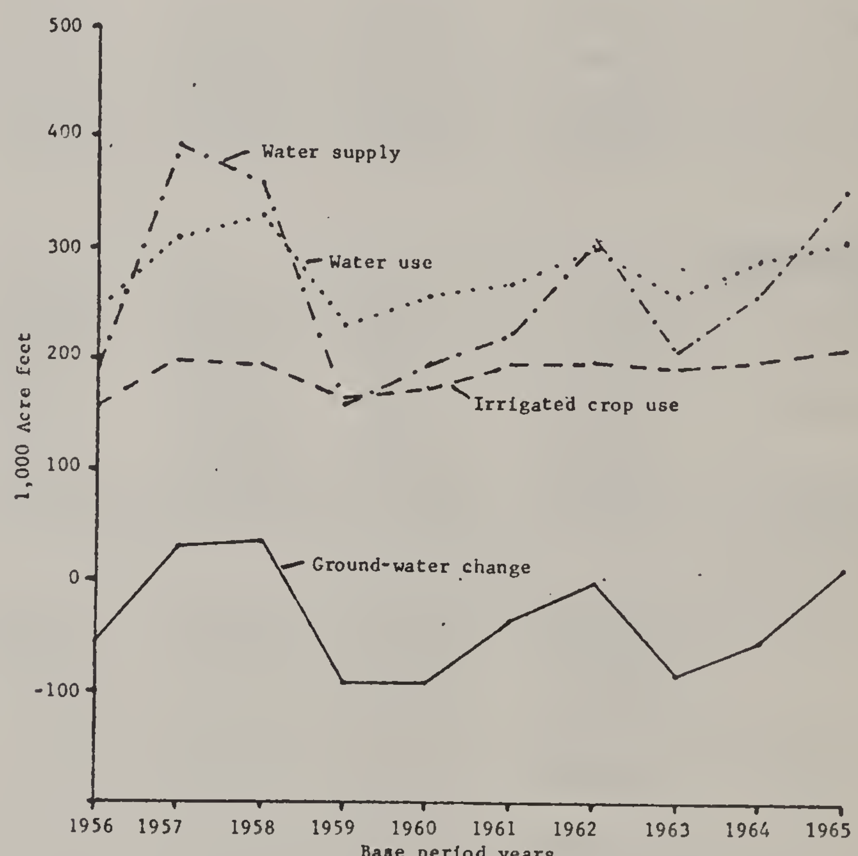

Figure 2 - Water resource availability and use within water budget areas, Beaver River Basin

[1]Present and Projected Resource Use and Management, Beaver River Basin, Appendix II (Water Budget Analysis Supplement).

[2]Data for 1956 and 1957 in the Escalante-Desert Subbasin were developed by extrapolation for use in this analysis and consequently these years and base period average figures do not agree with those in Appendix II.

Average annual use on irrigated cropland was 188,540 acre feet. Water use on irrigated cropland varied from a high of 208,300 acre feet during 1965 to a low of 156,390 acre feet in 1956. Water use on irrigated croplands was a result of precipitation on these lands, surface water diversions, direct use from ground water, and ground water pumping.

Average annual water use in the Basin was 278,680 acre feet. Total water use during the base period varied from a low of 229,900 acre feet to a high of 311,050 acre feet. Total water use was a result of irrigated cropland consumptive use, net consumptive use on wetland and native vegetation areas, net water surface evaporation and M&I use. Water use during the base period exceeded the available water supply by 138,000 acre feet. This use in addition to ground water outflows from the Basin resulted in 345,500 acre feet of ground water mining.

Available water supply and water use in the Fillmore Subbasin during the base period are shown in Figure 3. The average annual water supply was 74,360 acre feet and average annual use was 73,490 acre feet. This resulted in a water use and water availability ratio of .99 to 1.00 during the base period. This use combined with ground water outflows resulted in 111,100 acre feet of ground water mining during the 10 year period.

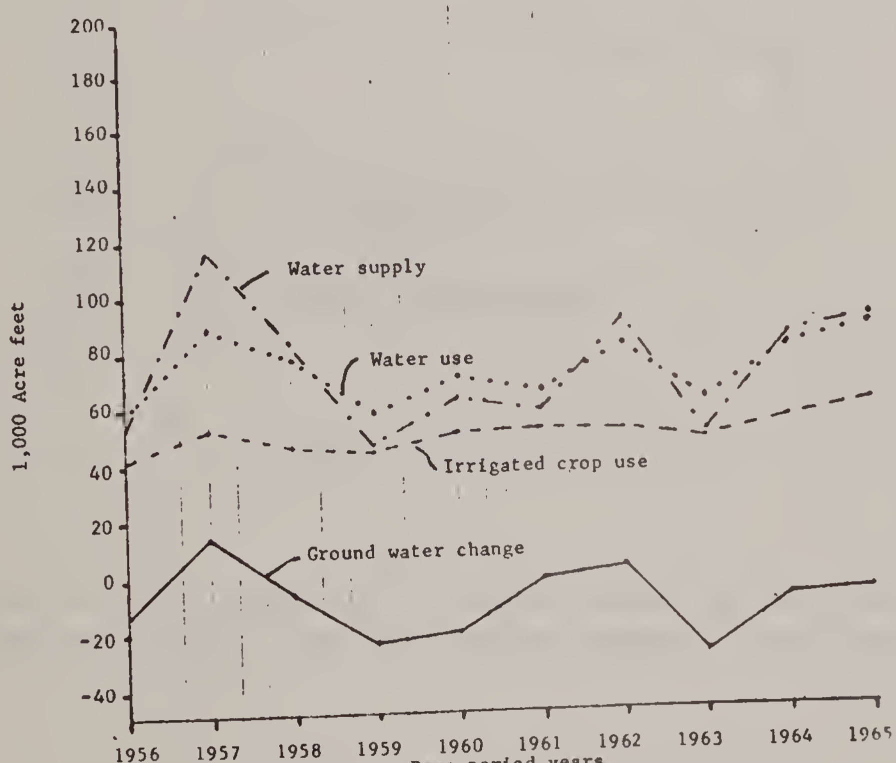

Figure 3 - Water resource availability and use within water budget areas, Fillmore Subbasin

Water use and availability summary for the Beaver-Milford Subbasin are shown in Figure 4. Average annual water use was 81,620 acre feet and the average annual available water supply was 78,550 acre feet. This resulted in 44,560 acre feet of ground water mining during the 1956-1965 base period. During 1959 and 1961, consumptive use of water on irrigated cropland exceeded the available water resource because of ground water pumping. During the base period, water use on irrigated cropland was 78 percent of the total available water supply.

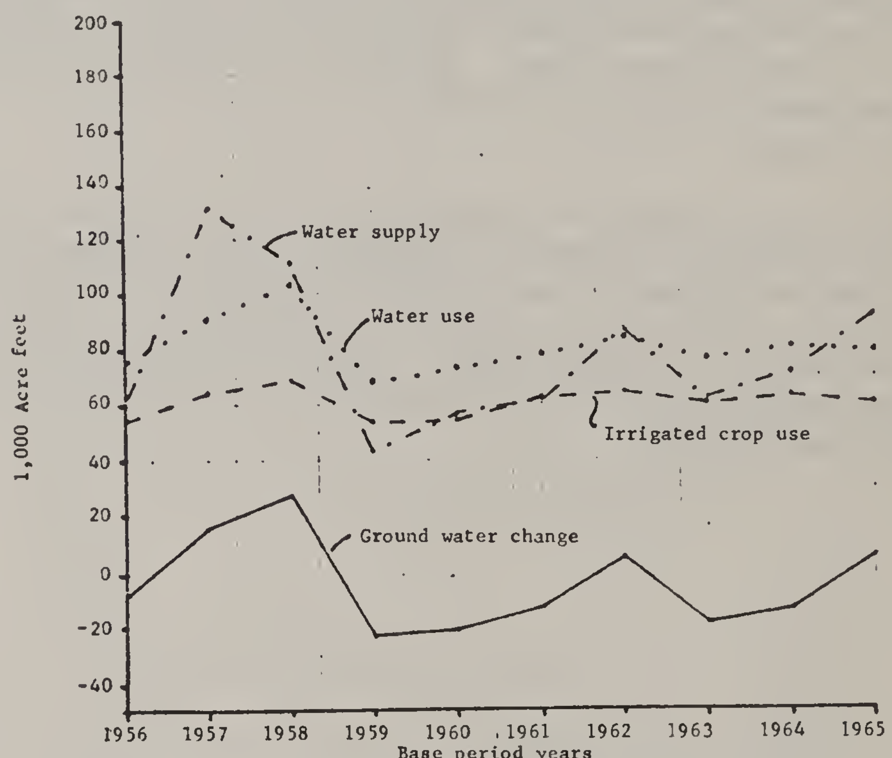

Figure 4 - Water resource availability and use within water budget areas, Beaver-Milford Subbasin

The average annual water supply in the Cedar-Parowan Subbasin was 78,320 acre feet. Average annual use was 77,300 acre feet which

resulted in a water use availability ratio of .99 to 1.00 shown in Figure 5. Ground water outflows in addition to uses within the area during the 1956-1965 base period resulted in 70,800 acre feet of ground water mining. Irrigated cropland consumptive use compared to the total water supply was the lowest of any of the subbasins (44 percent). Native vegetation and wetland areas in this subbasin use over one half of the available water supply.

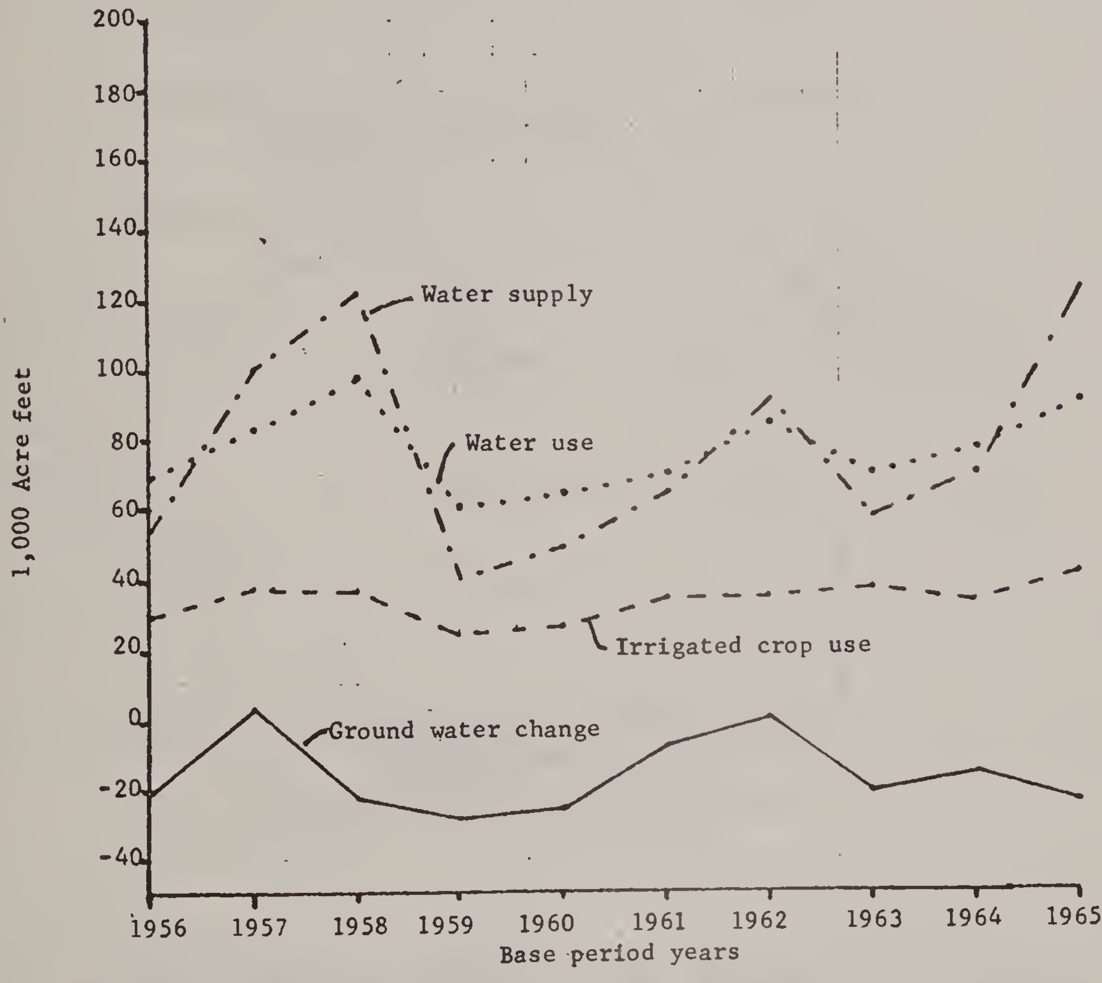

Figure 5 - Water resource availability and use within water budget areas, Cedar-Parowan Subbasin

The average annual water supply in the Escalante-Desert Subbasin is estimated to be 33,645 acre feet (Figure 6). Average annual irrigated cropland consumptive use was 46,270 acre feet during the 1956-1965 base period. This relationship resulted in 26 percent more consumptive use of water on irrigated crops than was available on an annual renewal basis. This use in addition to the other uses in the subbasin resulted in 119,020 acre feet of ground water mining during the base period. Other water uses in this area was the lowest of any subbasin (12 percent).

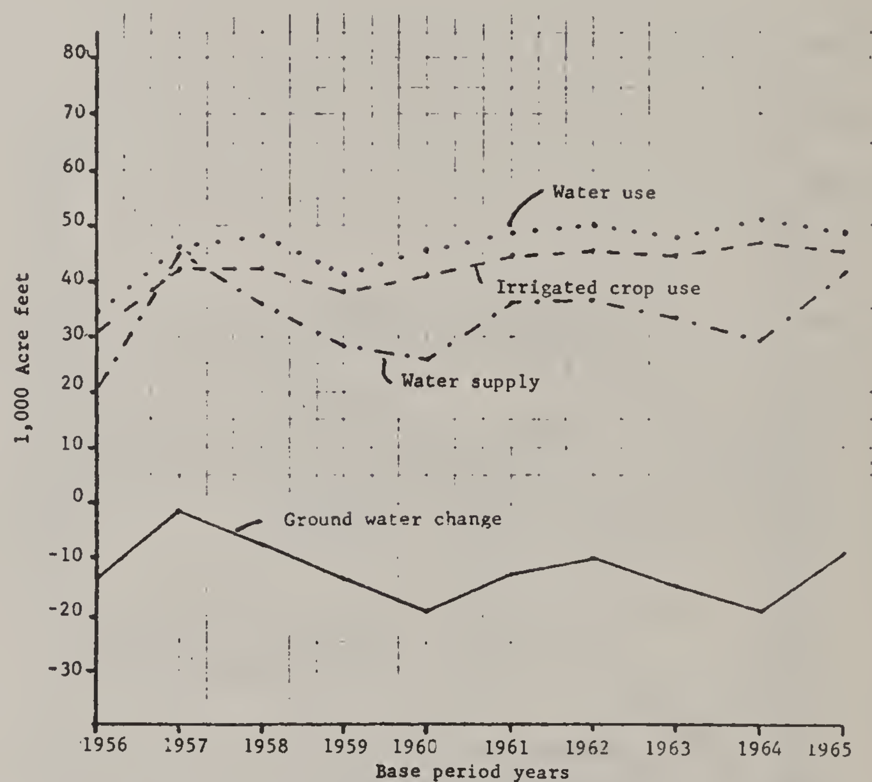

Figure 6 - Water resource availability and use within water budget areas, Escalante-Desert Subbasin[a]

[a] Data for 1956 and 1957 were developed by extrapolation for the economic analysis. Consequently the data for these years and base period average figures do not agree with those shown in Appendix II.

FARM ENTERPRISES

FARM NUMBERS AND SIZES

The present and projected number of irrigated farms are shown in Table 50. Projected farm numbers and associated unit crop production costs reflect a continuation of past trends. These numbers reflect operating units not farm ownerships. Projected farm sizes and irrigated rotation cropland per farm are shown in Table 51.

Table 50.--Present and projected number of irrigated farms, Beaver River Basin

Subbasin	1965	Projected 1980	Projected 2020
	Number	Number	Number
Fillmore	150	121	86
Beaver-Milford	162	131	92
Cedar-Parowan	210	170	120
Escalante-Desert	168	136	96
Beaver River Basin	690	558	394

Table 51.--Present and projected irrigated cropland acreage per farm Beaver River Basin

Subbasin	1965	Projected 1980	Projected 2020
	Acre	Acre	Acre
Fillmore	162	230	322
Beaver-Milford	135	210	300
Cedar-Parowan	110	136	190
Escalante-Desert	150	209	296
Beaver River Basin	136	191	270

CROP YIELDS

The present and projected average crop yields used in the simulation analysis are similar to those shown in Table 37 earlier in this report. Crop yields used in the model reflect a wide range of irrigation water supply situations and are too numerous to be shown here. However, yields used reflect assumptions of average management, increased fertilizer use and effective pesticide and herbicide controls.

Yield figures shown in Table 52 for the Beaver-Milford Subbasin illustrate one level which reflect farmers' estimates adjusted to a full water supply situation. Projected crop yields reflect an extension of past crop yield increases into the future. These are not average yields that are being obtained in the basin now or the average yield expected in the future. Yields for this level assume that an adequate irrigation water supply would be available.

Table 52.--Present and projected crop yields with full water supply, Beaver-Milford Subbasin

Crop	Priority	Unit	Yield per acre 1965	1980	2020
Barley nurse crop	1	Bu.	70.0	85.0	130.0
Barley	2	Bu.	70.0	85.0	130.0
Corn silage	3	Ton	14.0	18.0	24.0
Improved pasture	4	AUM	12.0	13.0	16.0
Alfalfa 2nd year	5	Ton	4.3	4.4	5.3
Alfalfa 3rd year	6	Ton	5.6	5.8	6.9
Alfalfa 4th year	7	Ton	5.4	5.6	6.6
Alfalfa 5th year	8	Ton	4.7	4.9	5.8
Alfalfa 6th year	9	Ton	4.3	4.4	5.3
Alfalfa 7th year	10	Ton	3.8	3.9	-
Alfalfa 8th year	11	Ton	3.4	-	-
Native pasture	12	AUM	7.0	7.0	7.0

CROP INCOME

The present and projected net crop income associated with crop yields are shown in Table 53. These figures represent potential incomes for various crops with no water, capital or labor restrictions. The 1965 figures are representative of net crop returns that could be achieved under present management conditions and farm sizes. The projected 1980 and 2020 net crop incomes reflect increased application of technology and continuation of past trends toward larger farms and machinery. Trends toward lower unit costs of crop production are also reflected in crop income figures.

Table 53.--Present and projected net crop income with full water supply, Beaver-Milford Subbasin

Crop	Net income per acre		
	1965	1980	2020
	Dollar	Dollar	Dollar
Barley nurse crop	-2.69	15.20	61.71
Barley	7.04	24.34	69.70
Corn silage	19.36	47.91	89.49
Improved pasture	28.39	36.69	56.48
Alfalfa 2nd year	26.20	38.42	67.62
Alfalfa 3rd year	49.81	64.86	104.45
Alfalfa 4th year	46.22	60.44	98.51
Alfalfa 5th year	33.90	46.70	80.01
Alfalfa 6th year	26.20	38.42	67.62
Alfalfa 7th year	17.65	29.27	-
Alfalfa 8th year	10.12	-	-
Native pasture	18.28	18.88	19.47

The simulation program has a monthly accounting system for soil moisture storage levels and associated net crop incomes. The available irrigation water is allocated to each crop in order of priority. Crop consumptive use requirements and on-site precipitation are also part of the program accounting system. When consumptive use needs excess available moisture, a portion of the crop with lowest priority is cut off until a balance between water used and available soil moisture is obtained. A crop is also cut off when there is insufficient moisture in the root zone to complete the growing season.

When a crop acreage is cut off because of lack of soil moisture or the end of the crop growing season, soil moisture consumptively used and net returns for the crop acreage are calculated. At the end of the growing season the area consumptive use of moisture and area net income are calculated. Figure 7 shows the relationship between alfalfa net returns and days in the growing season for the Beaver-Milford Subbasin. Similar data were prepared for all crops in the rotation in all subbasins.

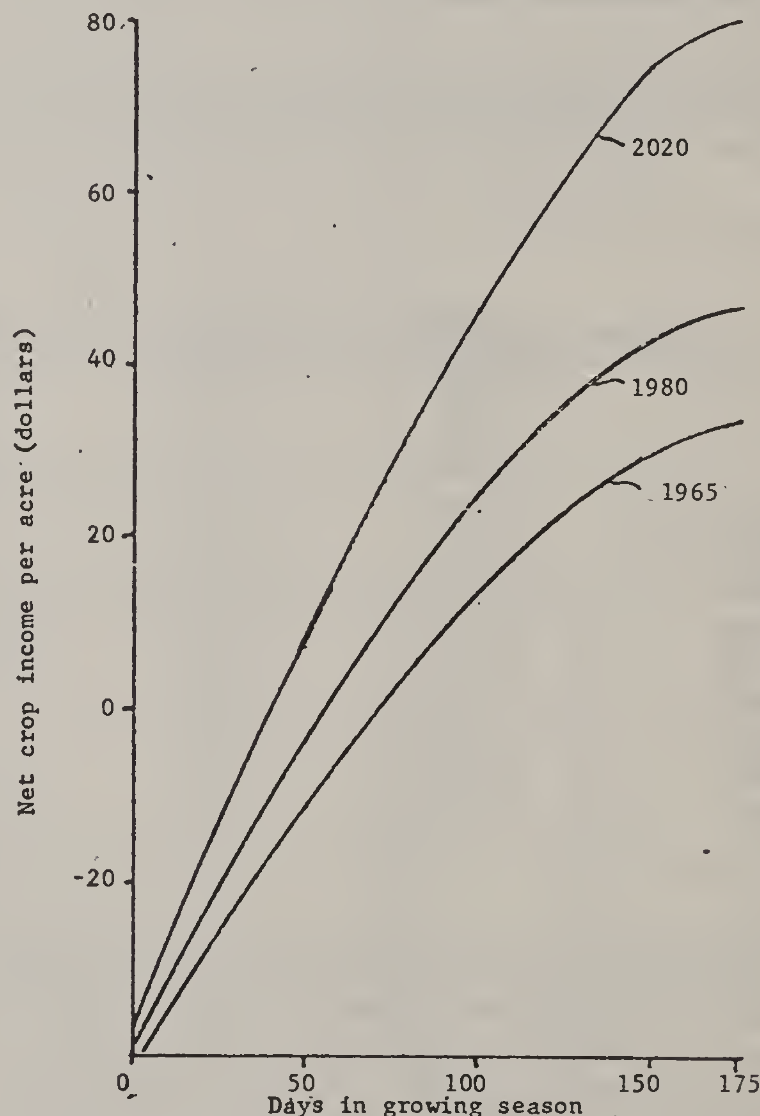

Figure 7 - Relationship between days in the growing season with adequate moisture and net crop income for alfalfa (5th year in rotation), Beaver-Milford Subbasin

PRESENT AND PROJECTED AREA CROP INCOME[1]

The "with-without" approach was used in evaluating impacts of resource use changes. A 1956-1965 time period was selected to be used as a base period in identifying present conditions and for projecting future conditions. Increased crop yields, larger farms, larger farm machinery, reduced labor inputs, increased fertilizer use, and continuation of going improvement programs were projected into the future. Crop rotation was held the same except the years of alfalfa in the rotation was reduced one year in 1980 and two years in 2020.

Both the water use pattern and Basin net crop incomes are projected to change over a period of time. The Basin average net crop income would increase from a minus $518,000 in 1965 to $784,000 in 1980. This represents a $1,302,000 increase in net crop income associated with technological changes and continuation of going farm programs. The application of the going on-farm and off-farm improvement programs are projected to reduce the average annual consumptive use deficit from 77,952 acre-feet to 50,290 acre-feet by 1980. A 1980 accelerated program would raise the 1980 Basin average annual net crop income to $1,019,900 and reduce the average annual consumptive use deficit to 45,190 acre-feet.

The projected 2020 Basin net crop income is $3,948,000. With the application of the going program, the average annual consumptive use deficit would decrease to 33,768 acre-feet. An accelerated program would decrease consumptive use deficits to 30,000 acre-feet and increase net crop income to $4,145,590.

Large annual variations in net crop income are experienced by farmers in the Beaver River Basin (Table 54). During the 1965 base period, net crop income ranged from a minus $1,584,000 to $570,000. Consumptive use deficits during this same period varied from 115,930 acre-feet to 31,670 acre-feet (Table 55). Projected net crop incomes indicate that this pattern will continue in the future. Projected net crop incomes show a range from a minus $417,000 to $2,037,000. Nineteen eighty consumptive use deficits will not be as large or vary as much as 1965 consumptive use deficits, but income variations will be larger than during the 1965 base period. This is a result of higher projected values for moisture used by crops. This same pattern of income variations would be present during the 2020 base period.

Potential Basin net crop income without any water shortage for each of the base periods would be 1965, $1,390,000; 1980, $2,379,000; and 2020, $5,775,000.

[1]Data for 1956 and 1957 in the Escalante Desert Subbasin were developed by extrapolation for use in this analysis and consequently these years and base period average figures do not agree with those in Appendices II and V.

TABLE 54.-- Projected net crop income without water resources development, Beaver River Basin[a]

Base Period year	Subbasin												Basin Total		
	Fillmore			Beaver-Milford			Cedar-Parowan			Escalante Desert					
	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020
	1,000 Dollars														
1	-425	-335	219	-319	14	717	-331	-172	320	-509	76	1,021	-1,584	-417	2,277
2	83	300	1,167	365	585	1,179	-35	237	820	-150	451	1,765	263	1,573	4,931
3	-175	37	742	420	566	1,142	-122	73	704	-334	173	1,496	-211	849	4,084
4	-321	160	433	-130	268	1,012	-485	-323	-3	-397	131	1,341	-1,333	-84	2,783
5	-177	6	633	-121	148	1,069	-501	-423	-63	-329	249	1,570	-1,128	-20	3,209
6	-211	-47	508	-83	295	1,037	-369	-170	168	-355	294	1,559	-1,018	372	3,272
7	-13	182	951	269	550	1,168	-81	112	645	-92	493	1,950	83	1,337	4,714
8	-263	-2	687	-11	438	1,132	-343	-86	292	-384	271	1,609	-974	621	3,720
9	155	448	1,393	241	536	1,217	-138	102	756	-105	488	1,734	153	1,574	5,100
10	232	575	1,380	266	566	1,234	186	398	1,029	-114	498	1,743	570	2,037	5,386
Average	-109	100	811	90	397	1,091	-222	-25	467	-277	312	1,579	-518	784	3,948
Potential	490	730	1,411	475	585	1,234	300	470	1,160	125	594	1,970	1,390	2,379	5,775

[a]Net crop income changes attributed to continuation of going program and technology changes

Table 55.--Present and projected consumptive use deficits without resource development, Beaver River Basin[a]

Base period year	Subbasin												Basin total[b]		
	Fillmore			Beaver-Milford			Cedar-Parowan			Escalante Desert[c]					
	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020	1965 Base period	Projected 1980	Projected 2020
1	42,533	36,986	30,186	21,543	10,306	4,091	24,540	18,280	13,683	27,314	19,922	14,472	115,930	85,494	62,432
2	20,132	14,744	8,781	3,300	-	-	13,645	7,878	4,389	13,681	5,555	2,204	50,758	28,177	15,374
3	31,906	25,483	18,866	1,549	42	-	18,920	13,574	9,222	20,586	13,882	8,323	72,961	52,981	36,411
4	33,859	28,100	22,047	21,141	7,660	5,574	29,074	22,864	17,536	24,775	18,331	12,499	108,849	76,955	57,656
5	31,536	25,989	20,141	22,914	10,937	4,186	31,548	25,324	20,537	23,233	13,778	8,418	109,231	76,028	53,282
6	26,521	21,344	15,515	15,512	5,341	1,913	23,438	18,640	15,121	19,625	12,071	7,941	85,096	57,396	40,390
7	24,265	19,513	13,320	5,824	263	6	14,902	10,342	7,140	12,296	4,976	791	57,287	35,094	21,257
8	28,042	20,608	12,576	16,806	2,330	781	19,519	13,407	8,240	19,781	12,233	4,757	84,148	48,578	26,354
9	16,004	10,166	3,379	8,826	349	-	17,421	9,862	5,332	12,334	4,877	4,164	54,585	25,254	12,875
10	9,048	2,835	594	6,246	-	-	5,657	1,817	31	19,720	12,284	10,925	31,671	16,936	11,550
Average	26,385	20,577	14,541	12,366	3,723	1,655	19,866	14,199	10,123	18,435	11,791	7,449	77,952	50,290	33,768

[a] Changes in consumptive use deficits are attributed to continuation of going programs only.

[b] Data for 1956 and 1957 in the Escalante Desert Subbasin were developed by extrapolation for use in this analysis and consequently these years and base period average figures don't agree with those in Appendix V.

[c] Ibid.

Average annual crop income in the Fillmore Subbasin is projected to increase from a minus $109,000 in 1965 base period to $100,000 by 1980. An accelerated program would increase average annual crop income to $192,500. Consumptive use deficits would be reduced from the present 26,385 acre-feet to 20,580 acre-feet with a going program to 17,630 acre-feet with an accelerated program. The projected 2020 net crop income for the Fillmore Subbasin is $811,000. The associated consumptive use deficit would be 14,540 acre-feet.

The average annual net crop income in the Beaver-Milford Subbasin should increase from $90,000 in 1965 to $397,000 in 1980. Consumptive use deficits should decrease from 12,370 acre-feet to 3,720 acre-feet. An accelerated program would increase income to $455,500 and decrease consumptive use deficits to 2,200 acre-feet. The projected 2020 net crop income would be $1,091,000 and consumptive use deficits would be 1,650 acre-feet. An accelerated program would decrease consumptive use deficits to 1,120 acre-feet and increase income by $31,000.

Average annual net crop income for the Cedar-Parowan Subbasin is projected to increase from a minus $222,000 in the 1965 base period to a minus $25,000 by 1980 period. Consumptive use deficits will decrease from 19,870 acre-feet to 14,200 acre-feet in 1980. An accelerated program would increase to $25,500 and reduce consumptive use deficits to 11,950 acre-feet. The projected 2020 income is $467,000 with consumptive use deficits of 10,120 acre-feet. A 2020 accelerated program would increase income to $578,600 and decrease consumptive use deficits to 7,930 acre-feet.

The average annual net crop income in the Escalante Desert Subbasin is expected to increase from a minus $277,000 during the 1965 base period to $312,000 by the 1980 period. The associated consumptive use deficits will decrease from 18,440 acre-feet to 11,790 acre-feet in 1980. An accelerated program would decrease consumptive use deficits to 10,490 acre-feet and increase income by $34,400. The projected 2020 income is $1,579,000 with deficits of 7,450 acre-feet. The 2020 accelerated program would increase income to $1,634,000 and reduce consumptive use deficits to 6,240 acre-feet.

VALUE OF WATER

The value of water has been estimated by simulating the consumptive use of soil moisture on irrigated cropland and associated net crop income over a series of 10 years (base period). Simulated results were plotted to establish a range of soil moisture deficit-net crop income relationships (Figures 8-12). These relationships were estimated for the 1965, 1980 and 2020 time periods.

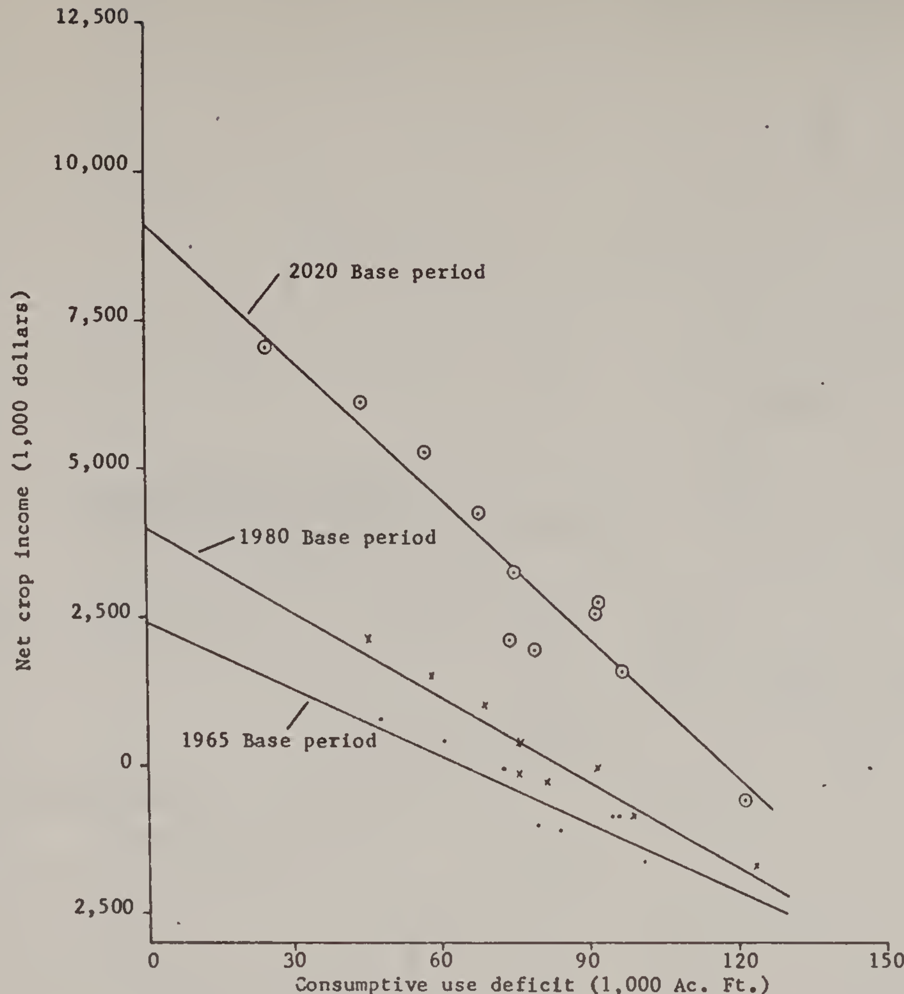

Figure 8 - Relationship between net crop income and consumptive use deficits on irrigated cropland, Beaver River Basin.

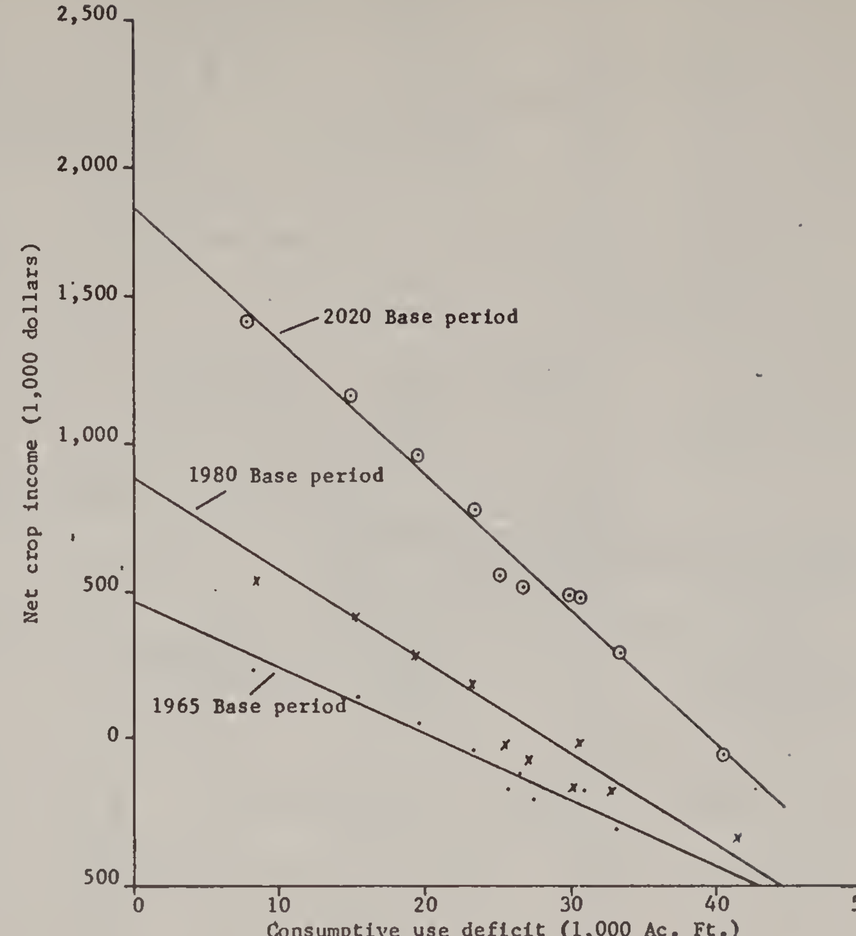

Figure 9 - Relationship between net crop income and consumptive use deficits on irrigated cropland, Fillmore Subbasin.

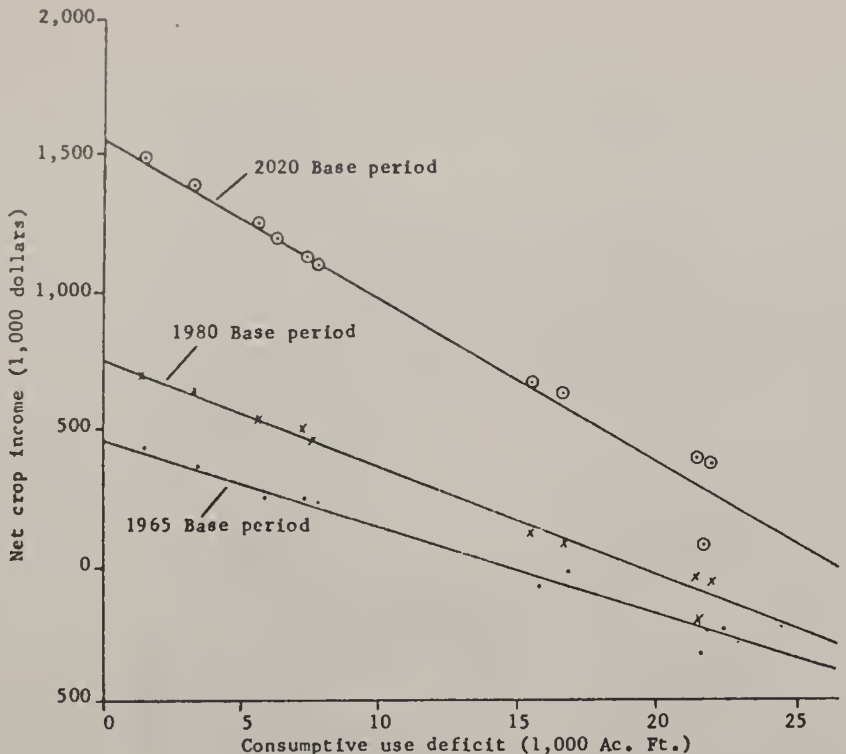

Figure 10 - Relationship between net crop income and consumptive use deficits on irrigated cropland, Beaver-Milford Subbasin.

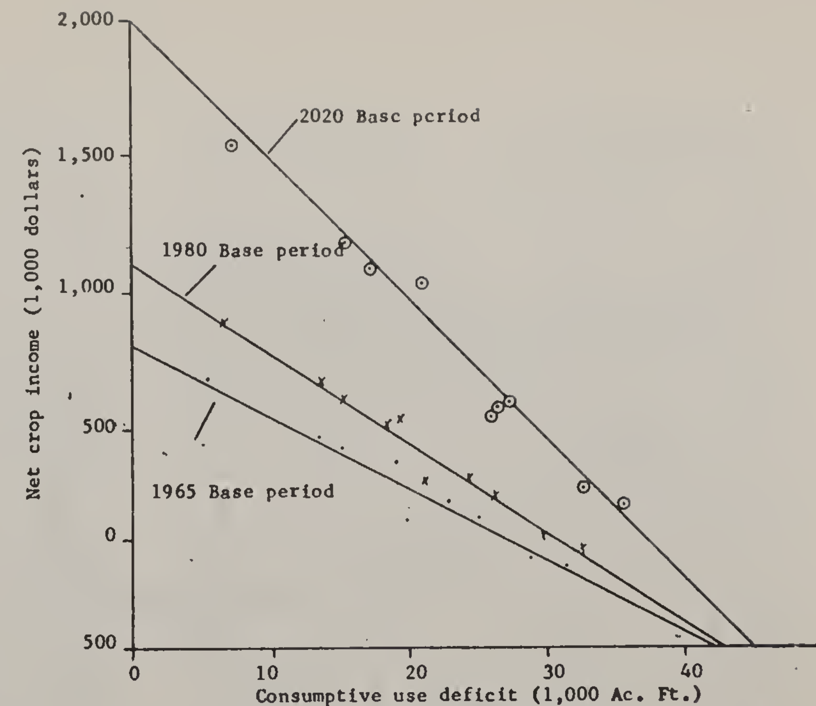

Figure 11 - Relationship between net crop income and consumptive use deficits on irrigated cropland, Cedar-Parowan Subbasin.

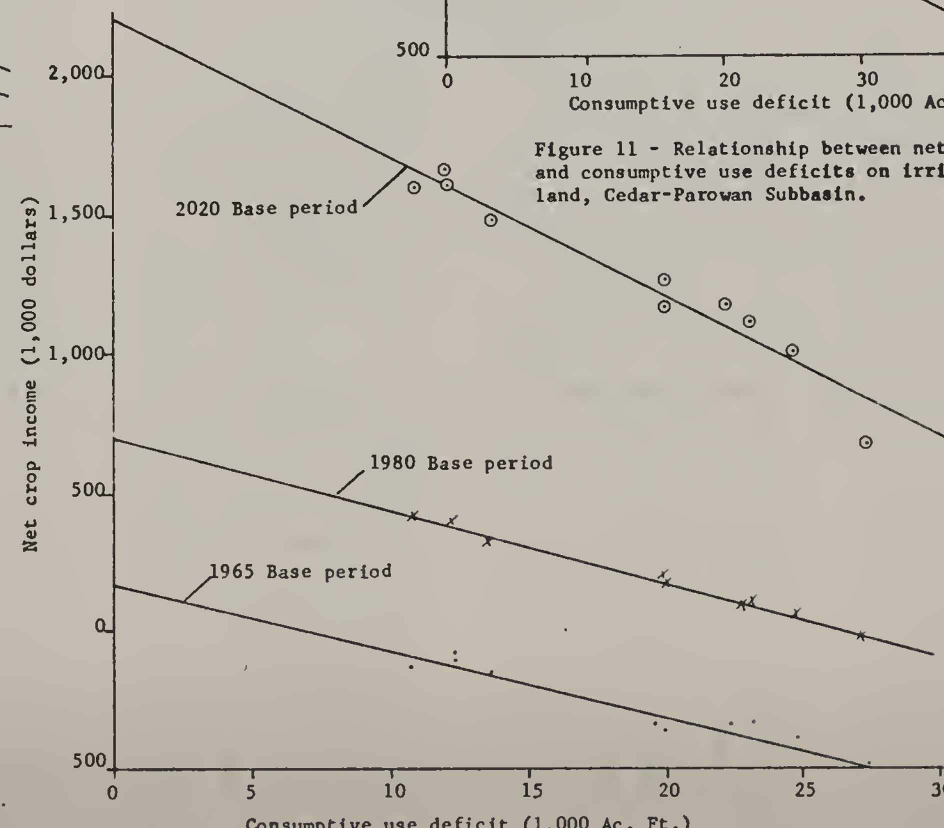

Figure 12 - Relationship between net crop income and consumptive use deficits on irrigated cropland, Escalante Desert Subbasin.

The average value of increased consumptive use of moisture on irrigated cropland for the selected time periods are shown in Table 56. Values are shown for each subbasin and the Beaver River Basin. The average value of increased consumptive use of root zone moisture in the Basin was $24.80 per acre-foot in 1965 and is projected to be $32.00 in 1980 and $50.20 in 2020.

Table 56.--Average value of root-zone water consumptively used on irrigated cropland, Beaver River Basin

Subbasin	Time Period 1965	1980	2020
	--------Dollars/ac.ft.--------		
Fillmore	23.00	31.50	45.75
Beaver-Milford	28.00	38.60	58.60
Cedar-Parowan	25,80	33.30	51.00
Escalante-Desert	24.20	26.70	49.50
Beaver River Basin	24.80	32.00	50.20

The value of increased consumptive use of moisture on irrigated croplands varies considerably between subbasins (Table 56). In the 1965 base period the value varied from $23.00 per acre-foot in the Fillmore Subbasin to $28.00 per acre-foot in the Beaver-Milford Subbasin. The projected 1980 values of increased consumptive use of moisture are estimated to be worth a high of $38.60 per acre in the Beaver-Milford Subbasin to a low of $26.70 in the Escalante-Desert Subbasin. Estimated 2020 values vary from a high of $58.60 in the Beaver-Milford Subbasin to a low of $45.75 in the Fillmore Subbasin.

The value of irrigation water at the point of diversion (stream diversion or at the pump) is a function of the efficiency with which water is made available and used by crops in the crop root zone. Therefore, irrigation water only has value when it is available at the right time and place. These requirements are met when water is available to be put in the crop root zone during times of soil moisture shortages (consumptive use deficits). Variations in the value of water at the point of diversion is a result of the efficiency with which the available water is transported and stored in the root zone for use by the plants (Table 57). These figures can be used as a guide in determining the value created by changes in the distribution and use of irrigation water. If an area has a water use efficiency of 40 percent and a practice is installed that increases the water use efficiency to

TABLE 57.--Value of irrigation water at the point of diversion at selected water use efficiencies and time periods, Beaver River Basin

Subbasin and time period	Water use efficiency (percent) 30	40	50	60
	Dollars/acre-foot			
Fillmore				
1965	6.90	9.20	11.50	13.80
1980	9.45	12.60	15.75	18.90
2020		18.30	22.88	16.65
Beaver-Milford				
1965	8.40	11.20	14.00	16.80
1980	11.58	15.44	19.30	23.16
2020	17.58	23.44	29.30	35.16
Cedar-Parowan				
1965	7.74	10.32	12.90	15.48
1980	9.99	13.32	16.65	19.98
2020	15.30	20.40	25.50	30.60
Escalante-Desert				
1965	7.26	9.68	12.10	14.52
1980	8.01	10.68	13.35	12.24
2020	14.85	19.80	24.75	29.70
Beaver River Basin				
1965	7.44	9.92	12.40	14.88
1980	9.60	12.80	16.00	19.20
2020	15.06	20.08	25.10	30.12

50 percent, the value of this change can be determined by taking the difference in the value of water between the 40 and 50 percent efficiencies. For example, in the Cedar-Parowan Subbasin, a change from 40 to 50 percent in the water use efficiency during periods of consumptive use deficits would have a value of $2.58 per acre-foot in the 1965 time frame and $3.33 in 1980 and $5.10 in 2020.

ALTERNATIVES[1]

GENERAL BACKGROUND

In assessing ways of extending the usefulness of the Beaver River Basin water resource, it seems logical to assume that the water resources are all being used or over used. This assumption can be substantiated by comparison of the total available water resource and total water uses in water budget areas during the 1956-1965 period. The average annual available water during this 10 year period was 584,000 acre-feet. Average annual water uses during this same period were 598,000 acre-feet. Thus total water uses during the 1956-1965 base period exceeded the available water resource by 140,000 acre-feet. In addition to ground water outflows, this use resulted in the Basin having a negative balance of ground water mining of 360,000 acre-feet during this 10 year period.

Individuals within our society place different values on water uses. Some members of society would indicate that consumptive use of water by phreatophytic vegetation has no value and others would see value in wildlife habitat that this water use stimulates. The problem in the Beaver River Basin isn't finding a use for water that has no value, but increasing the overall utility of water use or uses.

The effects of increasing the efficiency of use and total water use can only be answered by showing the results of that action on other uses. If goals to increase the utility of water are to be realized, the future consequences of these actions need to be studied.

A change in the present water use pattern or a specific use of water will have one or more of the following effects on the water resource: (1) change consumptive use rates; (2) change the time, place and availability of occurrence; (30 change quality; (4) affect land use; and (5) change in the overall environment.

The objective of irrigation is to place water in the crop root zone in the amount and proper time so that crop growth isn't inhibited. So far as the individual farmer is concerned, his objective

[1]Water supply figures used in this section are based on those shown in Appendices II and V. The figures that were used earlier in this report have a different base than these figures.

is to place as much of the available water as possible in the crop root zone to meet crop evaporation and transpiration needs. Quantities of water that are not retained in the root zone due to distribution losses, surface water runoff and deep percolation losses are a loss to the individual farmers. Presently, area water use efficiencies from the point of diversion to the crop root zone range from 28 percent in the Cedar-Parowan Subbasin to 36 percent in the Escalante Desert Subbasin and average 33 percent for the Basin.

These water use efficiencies can be misleading when considered in a large hydrologic system of which the individual farm is merely a part. For example, a high proportion of the water "losses" through canal losses, surface water runoff and deep percolation are still contained with a larger hydrologic system. In practice, the available water resource is often used and reused resulting in water use efficiencies considerably higher than indicated when evaluated on a small area approach. When the available water supply to irrigated lands (265,000 acre-feet) is compared to comsumptive use on irrigated cropland (190,000 acre-feet) the water use efficiency in the Basin is 71 percent. The present water use efficiencies by subbasins are as follows: Fillmore, 68 percent; Beaver-Milford, 78 percent; Cedar-Parowan, 44 percent; and Escalante Desert, 126 percent. When all water uses (not just consumptive use on irrigated cropland) are considered, the water use efficiency within the Basin is 102 percent. Water use efficiencies by subbasins are then as follows: Fillmore, 99 percent; Beaver-Milford, 102 percent; Cedar-Parowan, 99 percent and Escalante Desert 112 percent.

IRRIGATION WATER USE

There is a direct relationship between the consumptive use of water and agricultural crop income. In general terms, as water use increases, net crop income also increases. Therefore, the primary objective of agricultural water planning is to increase water available for use on irrigated croplands. There are several alternative ways of increasing the water available for consumptive use on irrigated croplands within the land and water resources of the area. Increased water available for consumptive use can be accomplished by the following means:

(1) Increase the surface water conveyance efficiency from the point of diversion to the farm headgate.
(2) Increase on-farm irrigation efficiencies.
(3) Storage of excess seasonal surface water.
(4) Increase irrigated cropland acreage.
(5) Increase pumping of ground water.
(6) Change in cropping pattern on irrigated lands.
(7) Combinations of the above practices.

GOING AND ACCELERATED PROGRAM

The going and accelerated programs within the Beaver River Basin were evaluated in detail and results shown earlier in this report. These programs are a combination of development alternatives 1 and 2 listed above. With these programs, consumptive use of water on irrigated cropland would increase from an average annual rate of 190,000 acre-feet during the 1965 base period to 223,000 acre-feet in 1980 and 234,000 acre-feet during the projected 2020 period. This would result in the efficiency of consumptive use on irrigated cropland compared to available water resource increasing from 71 percent in 1965 to 83 percent in 1980 and 87 percent in 2020. When other water uses are considered, the percentage would increase from 102 percent in 1965 to 108 percent in 1980 and 110 percent in 2020 (Table 58).

Table 58.--Comparison of present and projected total water use and available water supply, Beaver River Basin

Subbasin	Available water resource	Water use 1965	Water use 1980	Water use 2020	Comparison of available resource to use 1965	1980	2020
	(1,000 acre-feet)				(Percent)		
Fillmore	168	167	176	179	99	105	107
Beaver-Milford	134	137	147	148	102	109	110
Cedar-Parowan	185	184	192	195	99	103	105
Escalante-Desert	97	109	115	119	112	119	123
Beaver River Basin	584	598	631	642	102	108	110

Program alternatives could have a direct affect on the ground water resources. The average annual ground water decline during the 1965 base period was 36,000 acre feet. With the programs, this rate will be increased to 68,700 acre-feet in 1980 and 80,200 acre-feet by 2020, (Table 59), assuming that the increased consumptive use will have a 100 percent effect on the ground water reservoir.

Table 59.--Present and projected[a] ground water decline, Beaver River Basin

Area	1965	1980	2020
	Acre-feet	Acre-feet	Acre-feet
Fillmore subbasin	11,110	19,860	22,950
Beaver-Milford subbasin	4,460	14,590	15,580
Cedar-Parowan subbasin	7,080	14,700	18,420
Escalante Desert subbasin	13,350	19,600	23,300
Beaver River Basin	36,000	68,750	80,250

[a]Assuming consumptive use increase has 100 percent effect on ground water reservoir.

STORAGE OF SURFACE WATER

The volume of surface water available for irrigation does not have the same pattern during different periods of the year as crop consumptive use needs. This results in excess supply of irrigation water during the winter and spring months and irrigation water deficits during the summer and fall months. The timing and distribution of excess water can be changed to help meet water deficits during other months by providing reservoir storage. As the water conveyance and application efficiencies increase, the quantity of water that is excess to crop needs increases. The quantity of surface water at the point of diversion that is excess to present and projected needs are as follows: 1965, 58,000 acre-feet; 1980, 65,000 acre-feet; and 2020, 107,000 acre-feet. This water could be stored and released during times of water deficits to increase the consumptive use on irrigated croplands.

If a 10 percent reservoir evaporation loss is assumed, this means that consumptive use deficits of 15,000 acre-feet in 1965 base period, 23,000 acre-feet in 1980 and 53,000 acre-feet in 2020, could be eliminated by means of reservoir storage. The value of increased water for consumptive use resulting from reservoir storage would be $24.80 per acre-foot in 1965, $32.00 per acre-foot in 1980 and $50.20 per acre-foot in the 2020 time period. Increased water use resulting from reservoir storage would have a direct affect on the ground water mining rate and long-term pumping costs.

INCREASED IRRIGATED CROPLAND ACREAGE

Under the present land and water use pattern, there is 1.92 acre-feet of soil moisture consumbed by crops for each acre of irrigated land. The available moisture for each acre of irrigated land comes from precipitation (.88 acre-foot) and irrigation water (1.04 acre-foot).

If the same land and water use relationships are assumed in the future as exists now, as irrigation water conveyance and application efficiencies increase, the irrigated acreage could also increase. At the rate of 1.04 acre-feet per acre, projected increases in water use efficiencies could provide 40,390 acre-feet of water to irrigate an additional 38,830 acres by 1980. By 2020, this would provide 84,410 acres of new land if the irrigated acreage is allowed to vary year to year with the available irrigation water supply. The additional usable precipitation on these lands would be 34,000 acre feet by 1980 and 72,000 acre-feet by 2020.

GROUND WATER PUMPING

Ground water pumping has become a vital and interconnected part of the agricultural economy of the Beaver River Basin. During the 1956-1965 base period, 56 percent of the irrigation water use in the Basin was associated with pumping and 44 percent came from surface sources. Ground water development is relatively new in the Basin, since the majority of irrigation pumps were installed during the 1940's and early 1950's. In the late 1950's the water rights in the Beaver-Milford and Escalante Desert Subbasins were adjudicated and a 4 acre-feet per acre limit was placed on pump irrigated lands.

A very high area use efficiencies that have been noted earlier in this report are a result of the conjunctive use of the available water resources. A coordinated development plan will be necessary if the pump irrigation segment of the agricultural economy is to continue over the long term. An operating strategy that recognizes the interrelationship of the ground and surface water will be necessary to continue the present water use pattern in the various segments. The present pattern of water use has proven to be highly efficient and proper development would make the overall system more efficient.

Increased groundwater pumping could be considered as an alternative means of overcoming present consumptive use deficits on irrigated lands. Ground water is generally available throughout the irrigated areas and would be available for application during the entire growing season. Present and projected water deficits could be overcome by selective pumping of irrigation water.

A coordinated plan that recognizes the interconnection between surface and ground water can be developed to assure a more efficient and sustained agricultural economy. Surface water could be used during periods of high flows and ground water used only as needed during this period. The ground water could then be pumped during periods when surface flows are low to meet the crop needs. This type of a plan would need to limit the irrigated acreage to assure future availability of ground water.

CROPPING PATTERN

Research has been done by Giles, at Utah State University, on the effects of a limited water supply on land use and on-farm improvement practices. This research was done to determine the impacts of the court decree to limit ground water pumping in the Escalante Desert Subbasin.

Generally, this research concluded that under conditions of a limited water supply (4 acre-feet per acre) and low irrigation efficiencies (30%) that farm income would be maximized when the cropping pattern included 50 percent potatoes, 22 percent wheat and 28 percent idle land. When irrigation efficiencies were increased to the medium range (50%) the optimum combination of crops was 50 percent potatoes, 25 percent wheat and 25 percent alfalfa. With high irrigation efficiencies (70%) the cropping pattern remained the same, but excess water was available to irrigate additional land.

It can be concluded from this research that lands that are presently idle within irrigated farms will come into production as irrigation and conveyance efficiencies increase over a period of time.